Curtailment of reinforcement using Empirical Method

نسألكم الدعاء

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اذا حملت تطبيق RC Structures YASSER EL LEATHY على تليفونك المحمول او اللوح السطحى ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

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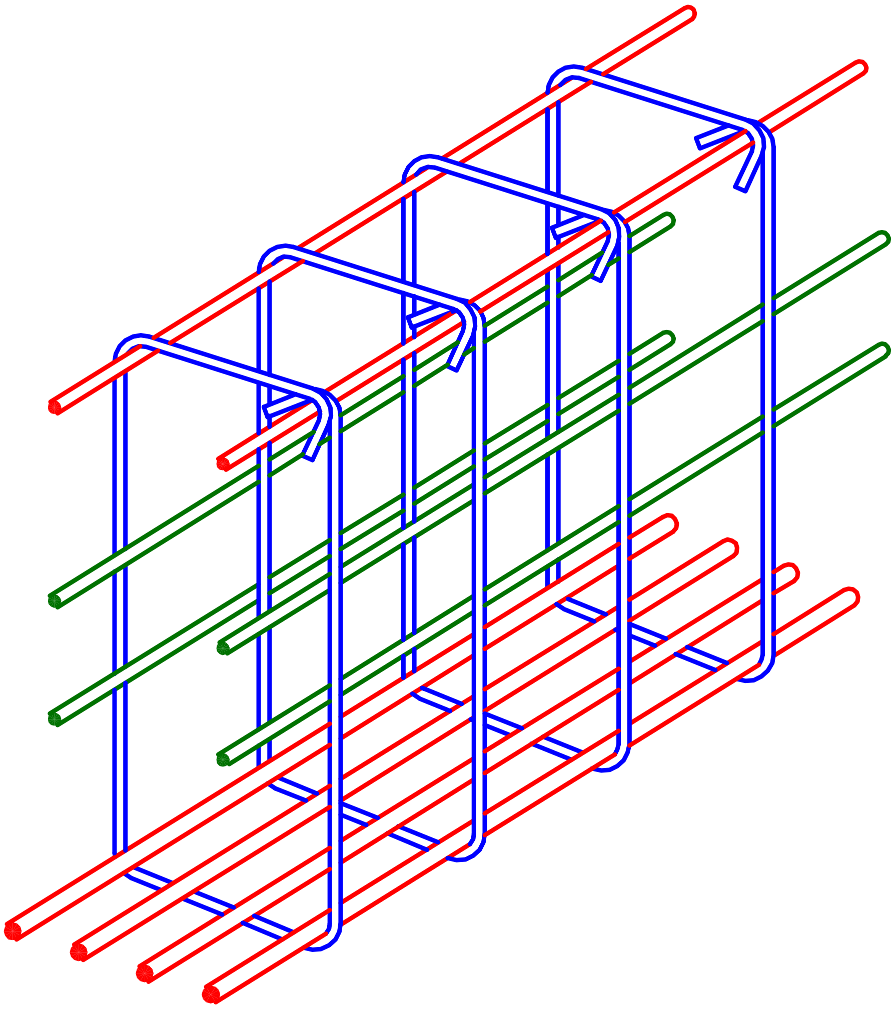
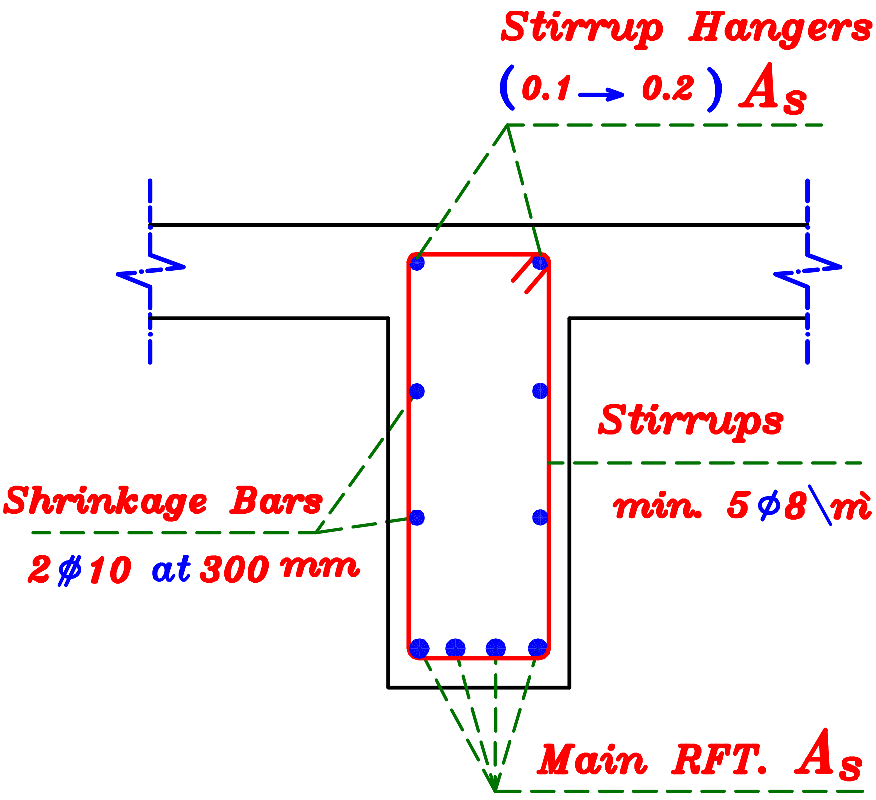
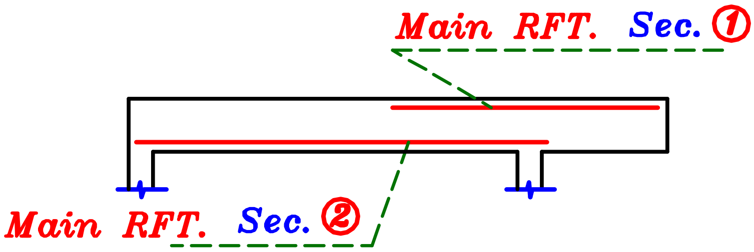
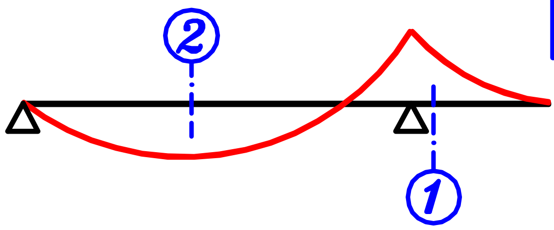
Reinforcement in Cross section.





① Main RFT. (A_s)





هو الحديد الرئيسى الموجود فى القطاع و يكون دائما جهه الشد أى يكون جهه ال moment

Choosing A_s

* $min\ \phi = \phi\ 12$ * $max\ \phi = \phi\ 25$
* max. No. of rows = 3 rows — أكبر عدد لصفوف التسليح يساوى ٣ صفوف .
* min. No. of bars in one row = 2 bars — أقل عدد أسياخ فى الصف الواحد تساوى ٢ سيخ .
* max. No. of bars in one row = n bar

أكبر عدد أسياخ ممكن وضعها فى الصف الواحد تساوى n

Calculation of max. No. of bars in one raw.

To get n , we have to get min. spacing between bars (S)

$$S = \left\{ \begin{array}{l} 25\ mm \\ \phi_{max} \\ max.\ size\ of\ aggregate + 5\ m.m. \end{array} \right\}$$ الأكبر $\simeq 25\ mm$

Take

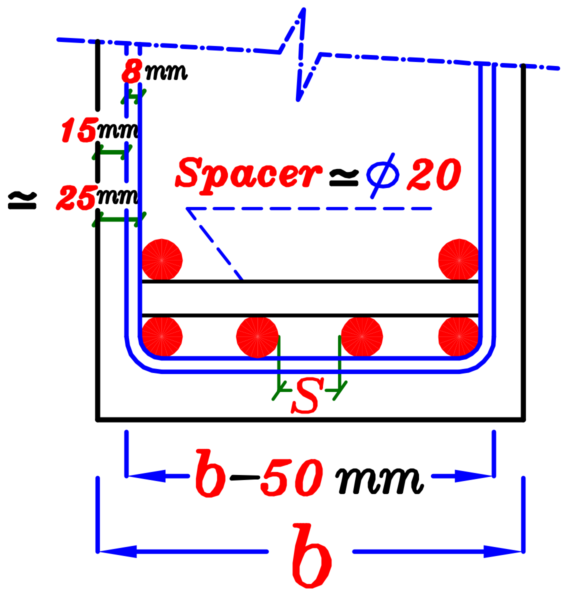
$$\boxed{S = 25\,mm}$$

$$b - 50 = n\,\phi + (n-1)(S)$$

$$\therefore\ b - 50 = n\,\phi + (n-1)(25)$$

$$\therefore\ b - 50 = n\,(\phi + 25) - 25$$

$$\boxed{n = \frac{b-25}{\phi + 25}}$$ حفظ



Example.

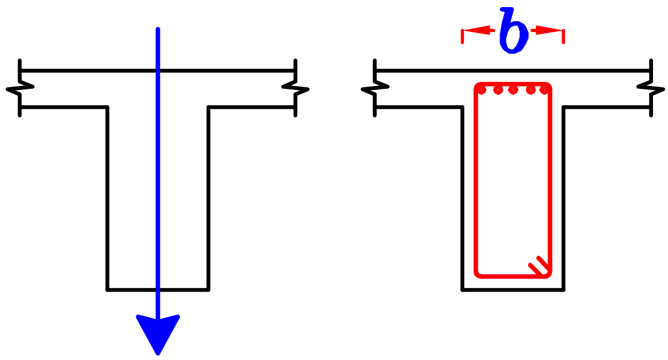
$b = 250\ mm$, $\phi\,16 = 16\ mm$

$$\therefore\ n = \frac{b-25}{\phi+25} = \frac{250-25}{16+25} = 5.48 = 5.0 \text{ bars in one row.}$$

العرض الذى يوضع به التسليح الرئيسى

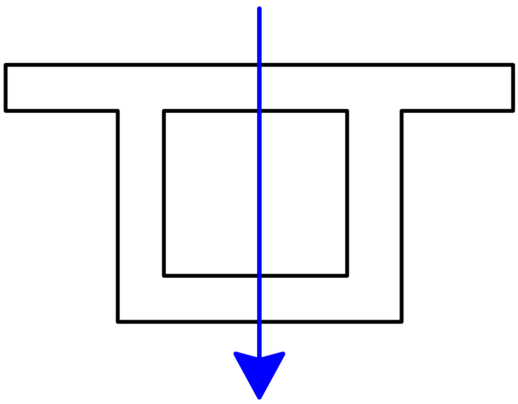
اذا كانت الـ ***Flange*** جزء من البلاطه

يوضع التسليح فى عرض الكمره فقط



$$n = \frac{b - 25}{\phi + 25}$$

Box section

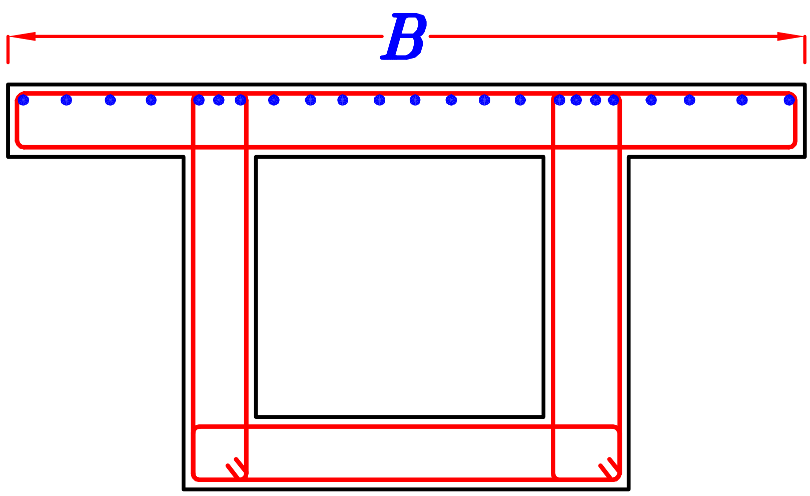


اذا كان القطاع غير موصول ببلاطه

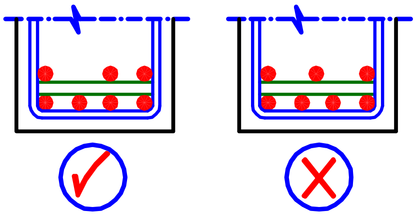
و لكن الـ ***Flange*** مستقله بالقطاع فقط

مثل ***Box section***

يوضع الحديد على كل الـ ***Flange***

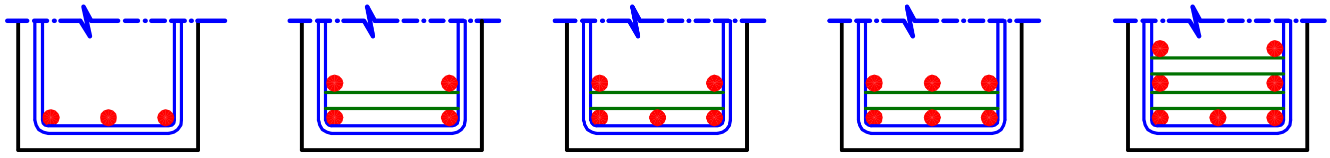


$$n = \frac{B - 25}{\phi + 25}$$



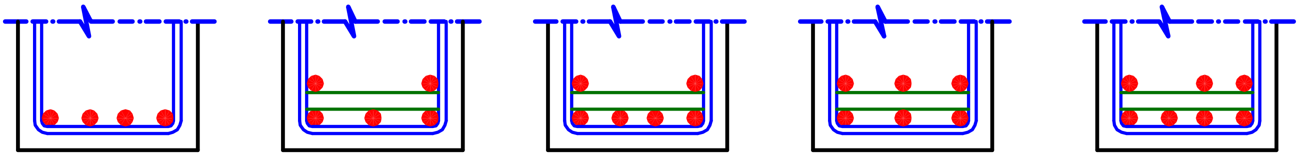
عند وجود أكثر من صف تسليح فى الكمره •
يجب أن يكون كل سيخ فى الصف العوى
يكون أسفلة سيخ فى الصف السفلى•

IF $n = 3$



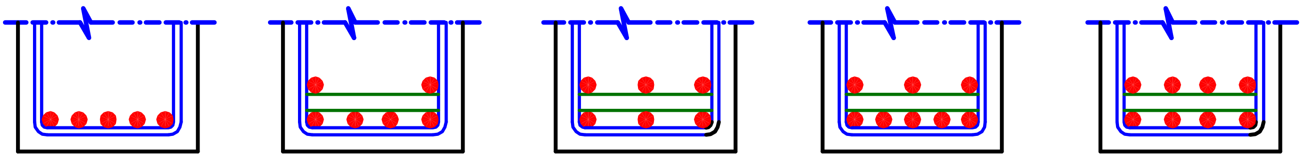
3 Bars | 4 Bars | 5 Bars | 6 Bars | 7 Bars

IF $n = 4$

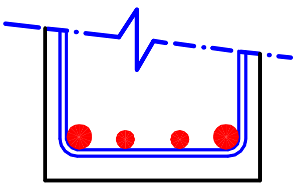


3 Bars | 4 Bars | 5 Bars | 6 Bars | 7 Bars not a Symmetric Sec.

IF $n = 5$



5 Bars | 6 Bars | 7 Bars | 8 Bars | 9 Bars



$2\phi16 + 2\phi18$

* ممكن استخدام قطرين مختلفين فى الكمره بشروط..

- أن يكونا متتاليان فى الجدول 12،16،18،20،22،25
- توضع الأسياخ ذات القطر الأكبر فى الأركان.
- نحاول على قدر الأمكان أن يكون القطاع Symmetric.
- أقل عدد من الأسياخ من كل قطر = ٢ سيخ.

Example.

$3\phi12$ ------------- (✓)

$2\phi12 + 2\phi16$ ------ (✓)

$2\phi12 + 1\phi16$ ------ (✗)

$2\phi12 + 3\phi16$ ------ (✓)

$2\phi12 + 2\phi18$ ------ (✗)

Area of Steel

$$A_s = \checkmark \ mm^2$$

ϕ \ No.	1	2	3	4	5	6	7	8	9	10	11	12
6	28.3	56.6	84.9	113.2	141.5	169.8	198.1	226.4	198.1	283	311.3	339.6
8	50.3	100.6	150.9	201.2	251.5	301.8	352.1	402.4	452.7	503	553.3	603.6
10	78.5	157	235.5	314	392.5	471	549.5	628	706.5	785	863.5	942
12	113	226	339	452	565	678	791	904	1017	1130	1243	1356
13	133	266	399	532	665	798	931	1064	1197	1330	1463	1596
16	201	402	603	804	1005	1206	1407	1608	1809	2010	2211	2412
18	254	508	762	1016	1270	1524	1778	2032	2286	2540	2794	3048
19	283	566	849	1132	1415	1698	1981	2264	2547	2830	3113	3396
20	314	628	942	1256	1570	1884	2198	2512	2826	3140	3454	3768
22	380	760	1140	1520	1900	2280	2660	3040	3420	3800	4180	4560
25	491	982	1473	1964	2455	2946	3437	3928	4419	4910	5401	5892
28	616	1232	1848	2464	3080	3696	4312	4928	5544	6160	6776	7392

الاقطار المشهوره فى مصر الوقت الحالى

ϕ \ No.	1	2	3	4	5	6	7	8	9	10	11	12
8	50.3	100.6	150.9	201.2	251.5	301.8	352.1	402.4	452.7	503	553.3	603.6
10	78.5	157	235.5	314	392.5	471	549.5	628	706.5	785	863.5	942
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25	491	982	1473	1964	2455	2946	3437	3928	4419	4910	5401	5892

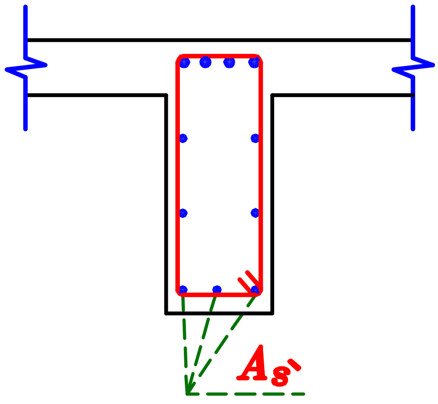
② Compression Steel ($A_{s`}$)

و هو الحديد الذى يوضع فى منطقة الضغط إذا ما إحتاج القطاع إلى ذلك .

ممكن وضع ال $A_{s`}$ فى ال R-Sec. فقط

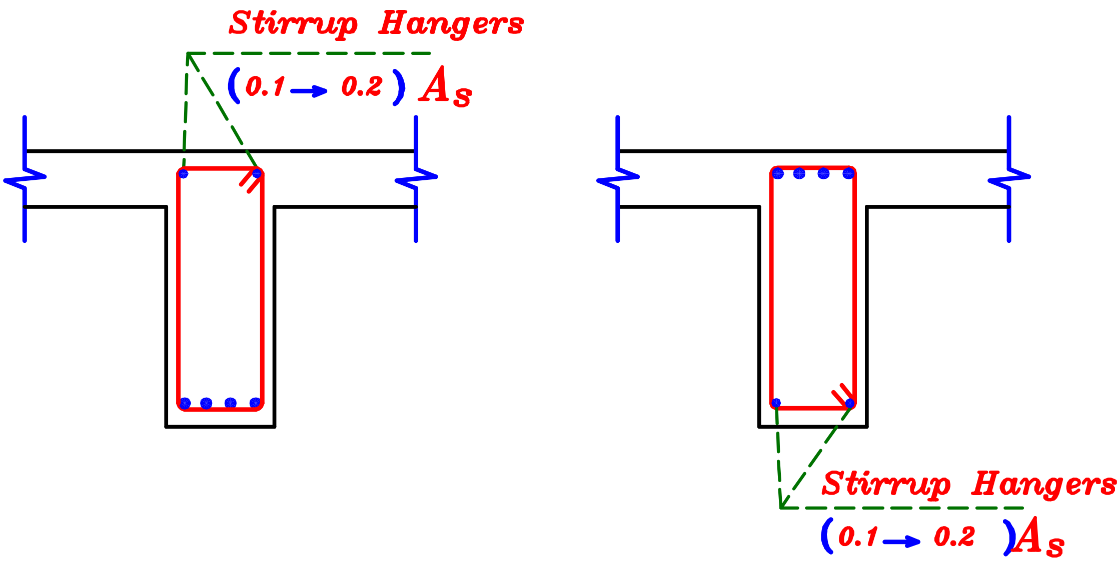
و لا يمكن وضعة فى ال T-Sec. & L-Sec.

$$\boxed{A_{s`_{max.}} = 0.40\ A_s}$$



R-Sec.

③ Stirrup Hangers. تعليق الكانات



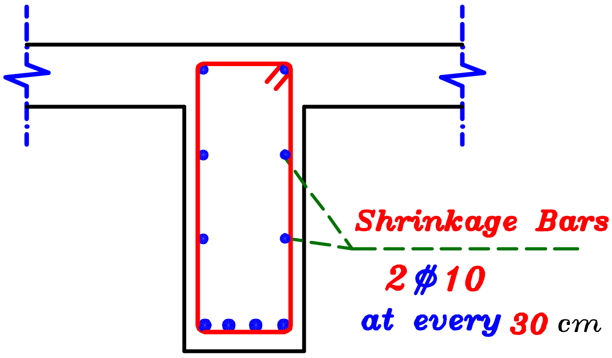
T-Sec. R-Sec.

- هى أسياخ توضع فى جهه الضغط إذا لم نحتاج الى $A_{s`}$.
- وظيفتها هى تعليق الكانات عليها لذا تسمى Stirrup Hangers .
- تعتبر ال Stirrup Hangers عباره عن Secondary Steel . أى أننا نهمل وجودها فى الحسابات .
- توضع ال Stirrup Hangers فى كلاً من R-Sec. & L-Sec. & T-Sec.
- قيمه ال Stirrup Hangers فى القطاع تكون الأكبر من .

$$\left.\begin{array}{l} (0.1 \rightarrow 0.2)\ A_s \\ 2\phi 10 \quad \text{Beams} \\ 2\phi 12 \quad \text{Frames} \end{array}\right\}$$ الأكبر

④ Shrinkage Bars.

ـ و هى عباره عن أسياخ حديد توضع فى جانبى الكمره لتقليل إنكماش الخرسانه



ـ و نحتاج الـ **Shrinkage Bars** فقط عندما تكون $t > 700$ mm

ـ قيمة الـ **Shrinkage Bars** هى الأكبر من $\left\{ \begin{array}{l} 0.08\ A_s \\ 2\phi 10 \text{ at every } 300 \text{ mm} \ \checkmark\checkmark \end{array} \right.$

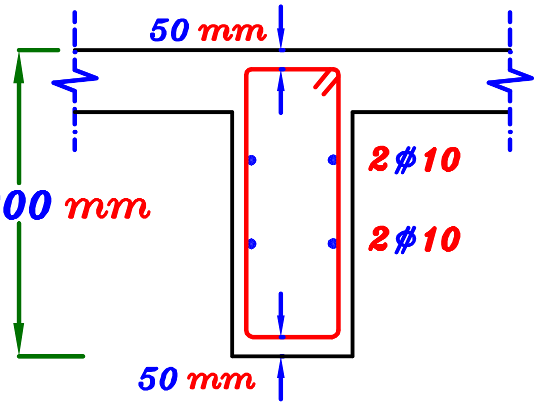
Example.

IF $t = 800$ mm

$\therefore$ No. of Spacing =

$$= \frac{800-100}{300} = 2.33 = 3.0 \text{ Spacing}$$

$$= 2.0 \text{ Bars}$$

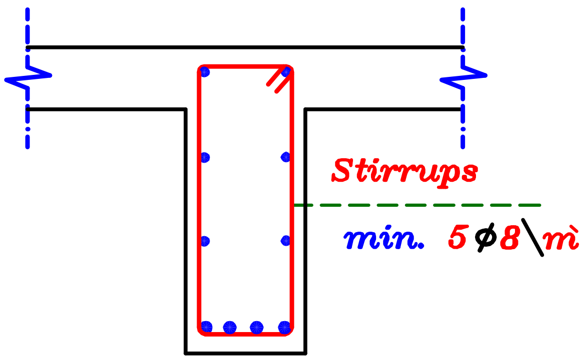


⑤ Stirrups. الكانات

توضع الكانات فى الكمرات لـ

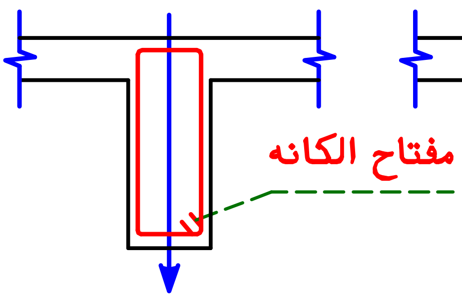
ـ مقاومه الـ **Shear Stress**.

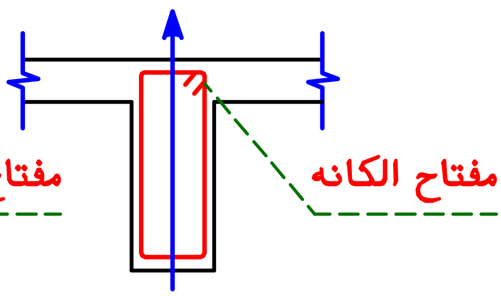
ـ للربط بين الخرسانه فى منطقه الضغط و الحديد فى منطقه الشد.



ـ أقل قيمه للكانات فى الكمره هى $5\phi 8 \backslash \grave{m}$.

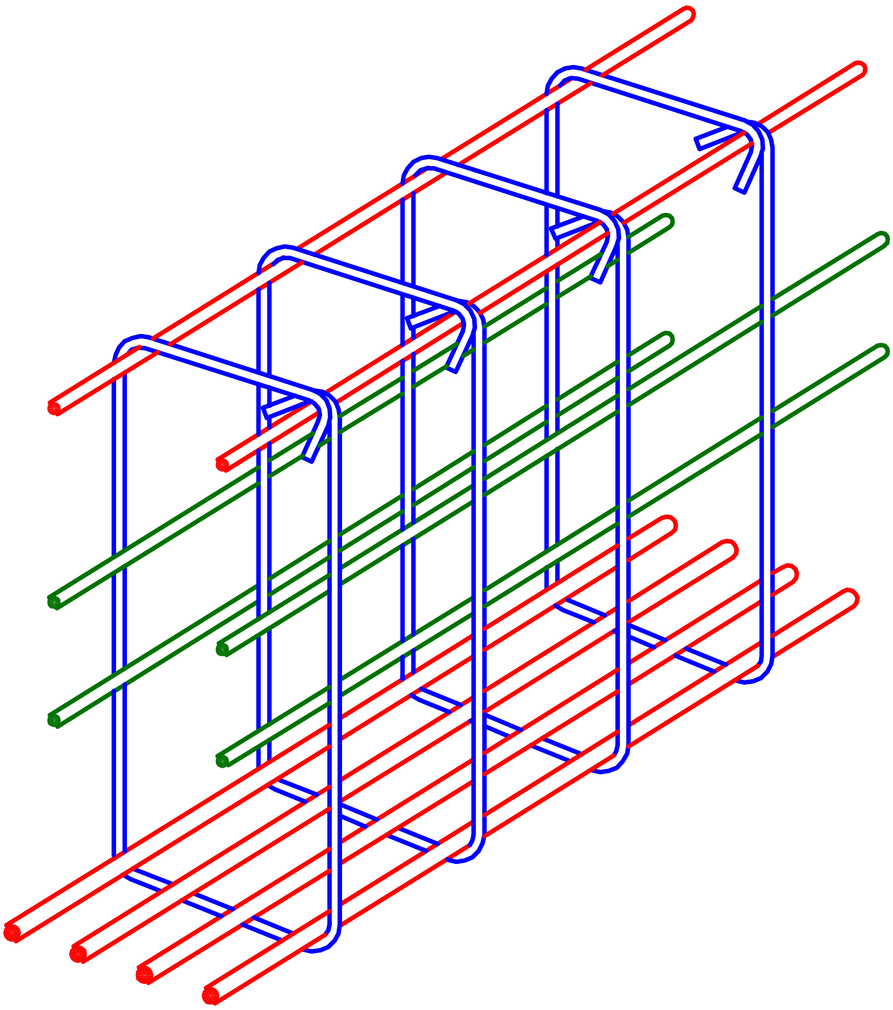
ـ مفتاح الكانه يكون دائما جهه الضغط .

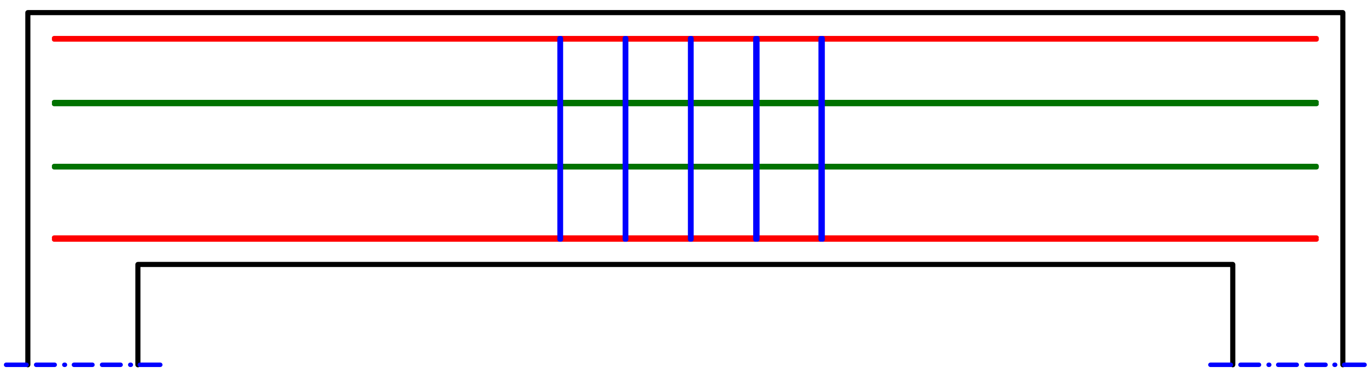




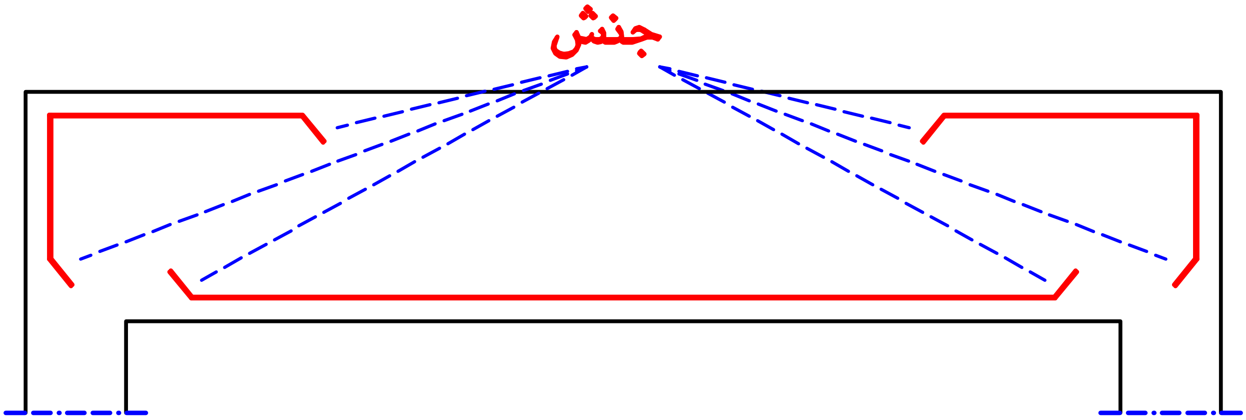
Reinforcement in Elevation.

تسليح الكمره فى ال ***elevation*** يظهر على شكل خطوط.

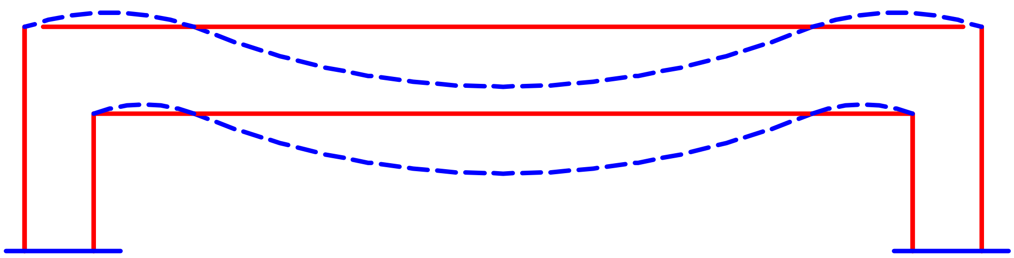


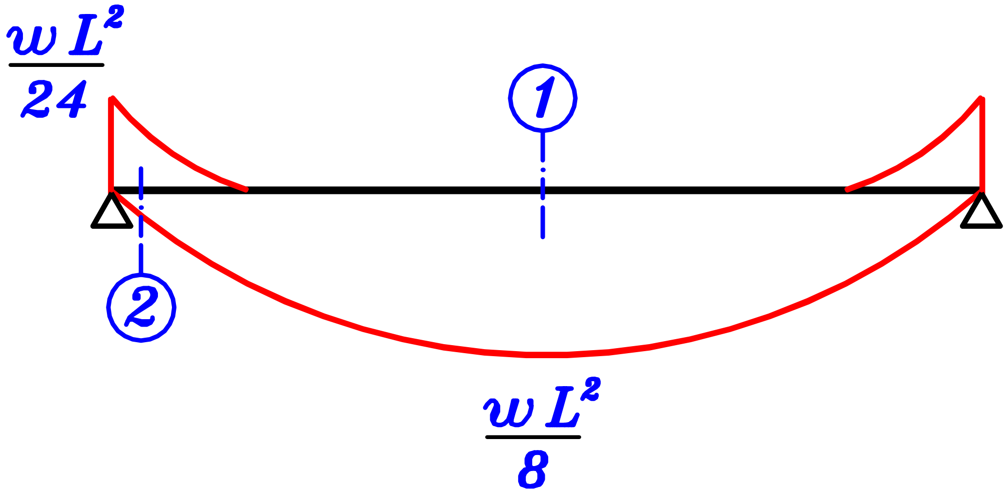


دائما عند نهايه السيخ نرسم جنش بزاويه منفرجه و دائما للداخل .



عند تسليح الكمره فى ال *elevation* يجب تصميم قطاع فى طرف الكمره على عزم $\frac{wL^2}{24}$





Curtailment of reinforcement using Empirical Method

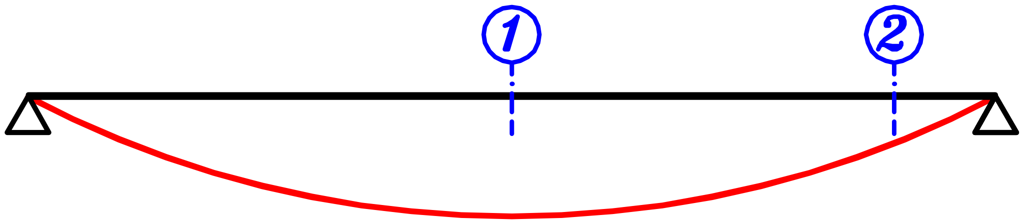
توقيف أسياخ الحديد باستخدام القيم التجريبيه .

للتوفير فى كميات الحديد يفضل تقسيم الحديد الرئيسى الى نصفين

١- نصف الحديد (أو أكثر) يمتد لتغطيه العزم بالكامل مع زياده فى الطول .

٢- نصف الحديد (أو أقل) يوضع فى منطقه *max-moment* فقط.

و ذلك للتوفير فى كميات الحديد .

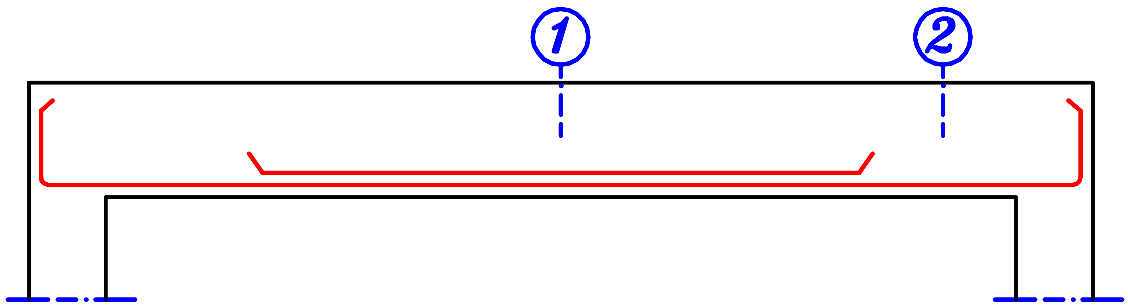


مثلا اذا كان القطاع الاوسط *Sec.* ① (عيله أكبر عزم سفلى)

يحتاج الى ٦ أسياخ سفليه .

فسنكمل ٣ أسياخ فقط من وش العمود الى وش العمود .

و باقى الاسياخ لن تكمل حتى أخر الكمره .

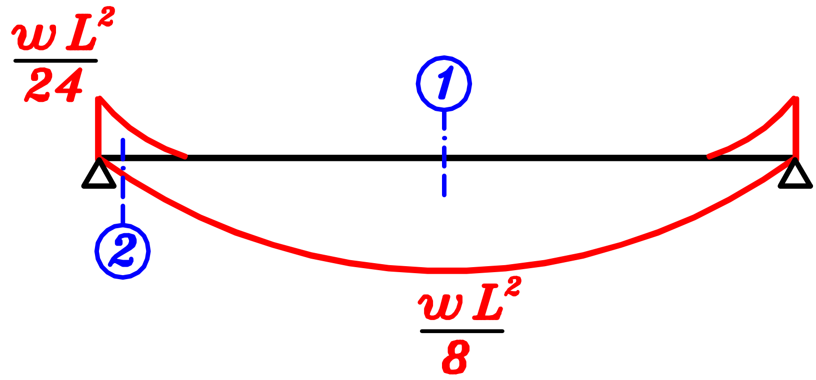


فيكون القطاع الاوسط (عيله أكبر عزم سفلى) يمر به ٦ أسياخ سفليه .

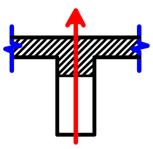
و يكون القطاع *Sec.* ② (عيله عزم سفلى أقل) يمر به ٣ أسياخ فقط.

و ال ٣ أسياخ التى ستقف تقف عند مسافات معينه تسمى *Empirical Values*

Simple Beam.

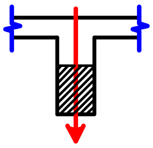


لتصميم الكمره الـ *Simple* يوجد قطاعان



عاده نبدأ بتصميم $\frac{wL^2}{8}$ و عاده يكون *T-sec.*

نحدد له d , A_s $\boxed{K = 1.0}$



ثم نصمم القطاع $\frac{wL^2}{24}$ و عاده يكون *R-sec.*

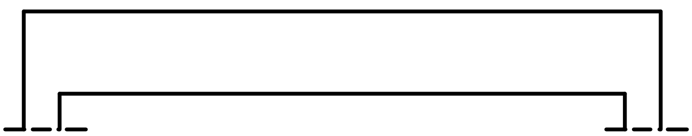
نأخذ نفس d للقطاع الاول و نحدد A_s فقط

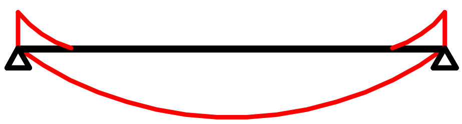
ملحوظه

فى هذه الحاله صممنا القطاع الـ *T-sec.* أولا لان $M_{T-sec} > 2M_{R-sec}$

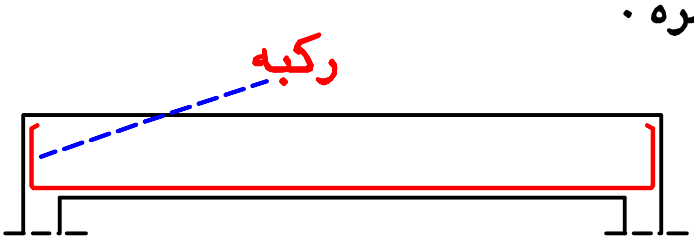
خطوات رسم تسليح كمره *Simple* فى الـ *elevation*

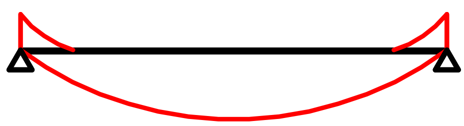
١- نرسم شكل الكمره بمقياس الرسم المطلوب



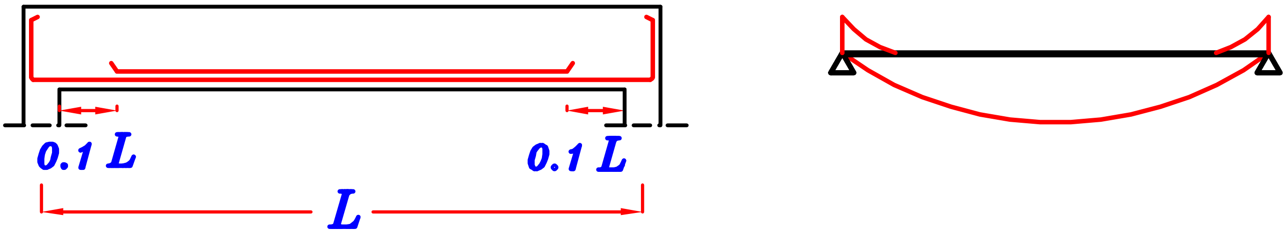


٢- نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره .

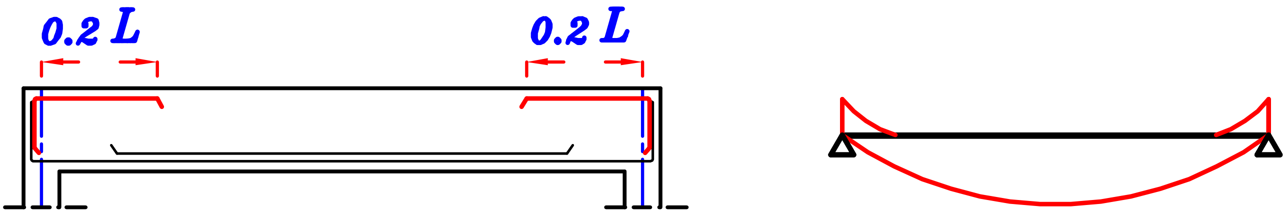




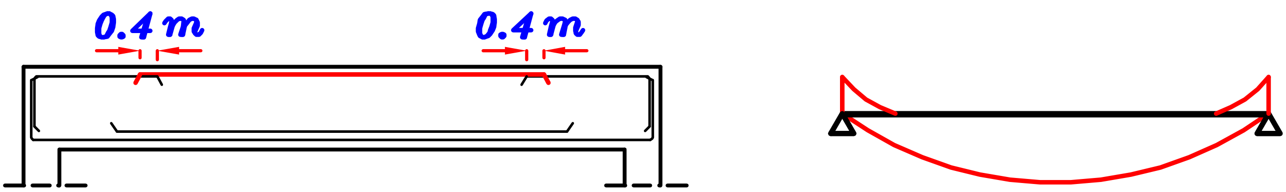
٣- باقى التسليح السفلى حتى مسافه $0.1\ L$ من وش العمود الداخلى .
حيث L هى *span* الكمره من *C.L.* الاعمده .



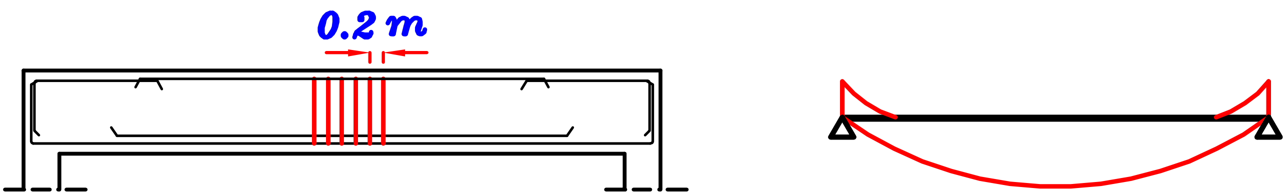
٤- نرسم التسليح الرئيسى للعزم $\frac{wL^2}{24}$ يعمل ركبه لاسفل عند نهايه الكمره
و من أعلى يمتد حتى مسافه $0.2\ L$ من *C.L.* العمود .



٥- فى المنطقه الباقيه نمد تسليح *Hangers stirrup*
و يعمل تداخل مع التسليح الرئيسى مسافه $0.4\ m$



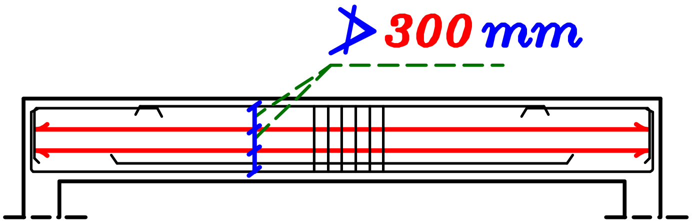
٦- نرسم تسليح الكانات عباره عن خطوط طوليه من الحديد الى الحديد فقط
و تكون هذه الخطوط فى منتصف الكمره و تكون المسافات بينهم $0.2\ m$

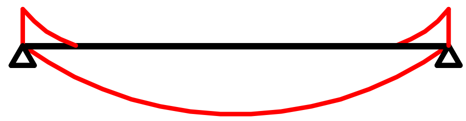


٧- اذا كان عمق الكمره أكبر من *700 mm* نضع تسليح فى الكمره يسمى ***Shrinkage bars*** المسافه بينهم لا تزيد عن *300 mm*

و فى أخر ال ***Shrinkage bar*** نضع شكل أسمه ضُفر

و ال ***Shrinkage bar*** يمتد من أول الكمره الى أخرها .



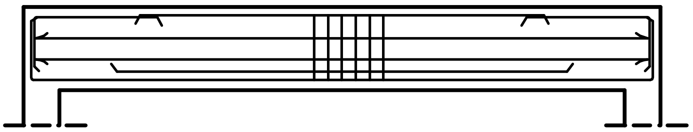


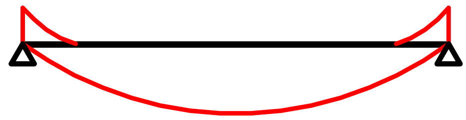
٨- أسفل تسليح الكمره مباشره نرسم **التفريد** و يكون بنفس مقياس رسم الكمره

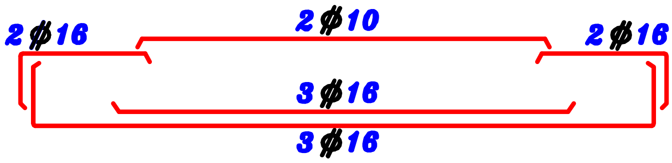
و فى التفريد نبعد الاسياخ عن بعضها فى حدود ٥ مم و نكتب عليها عدد الاسياخ

و نفرد تسليح رئيسى و ***Hangers stirrup*** فقط

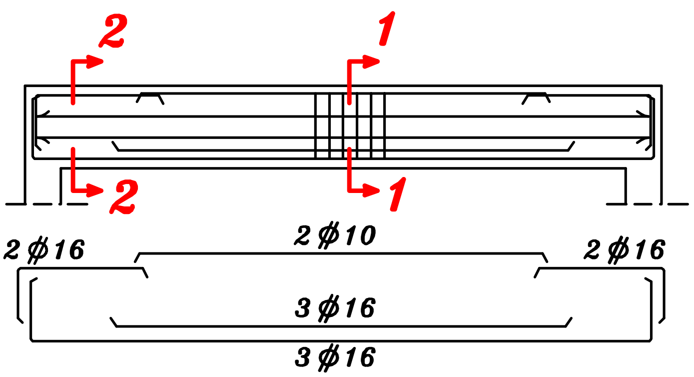
و لا نفرد الكانات و لا ال ***Shrinkage bars***

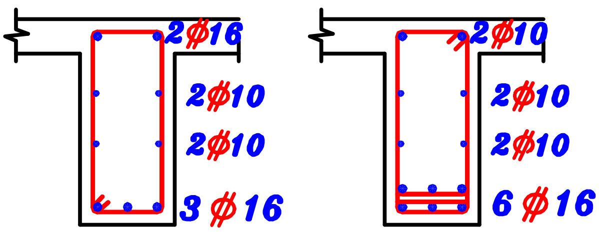




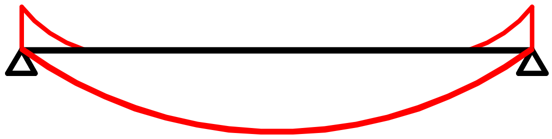


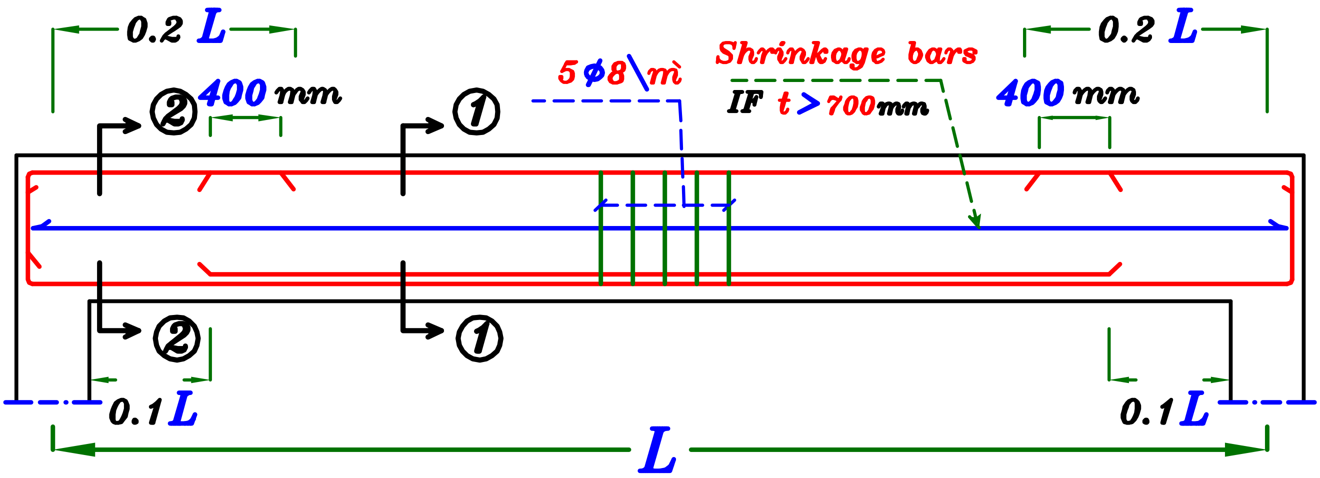
٩- نرسم تسليح الكمره فى ***cross sections*** بمقياس رسم أكبر

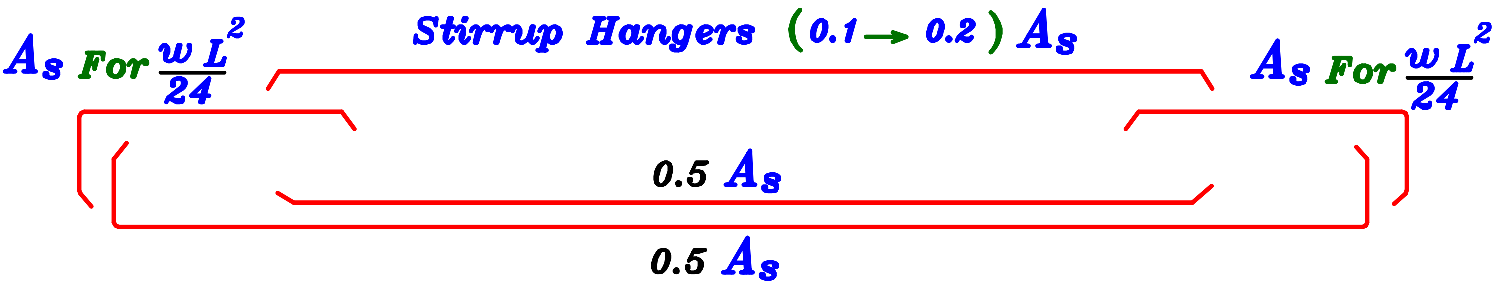


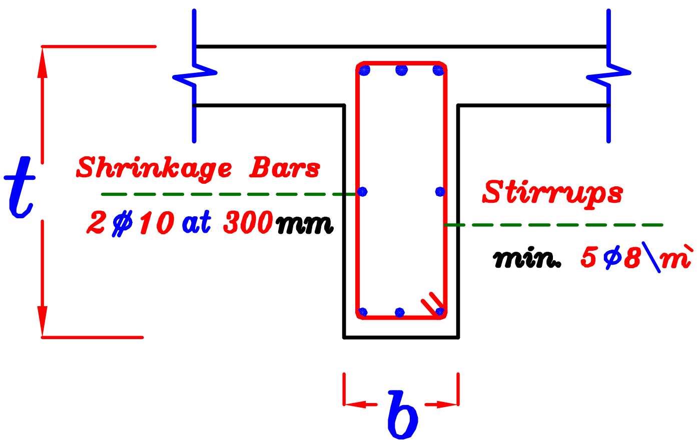


Simple Beam.

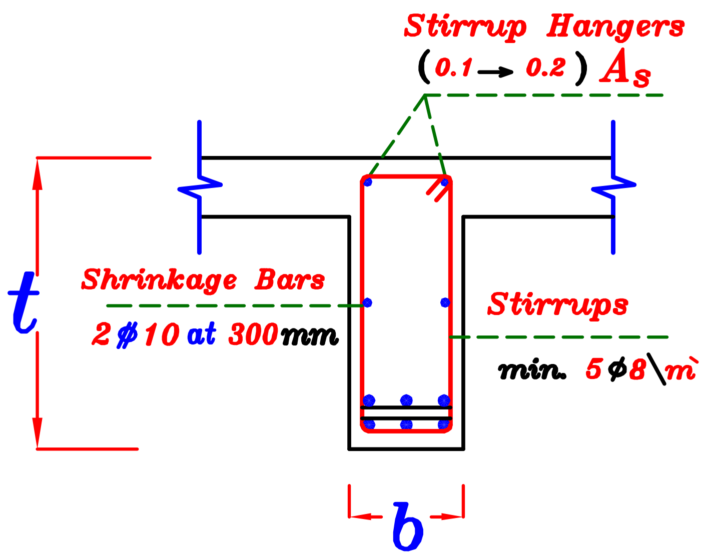






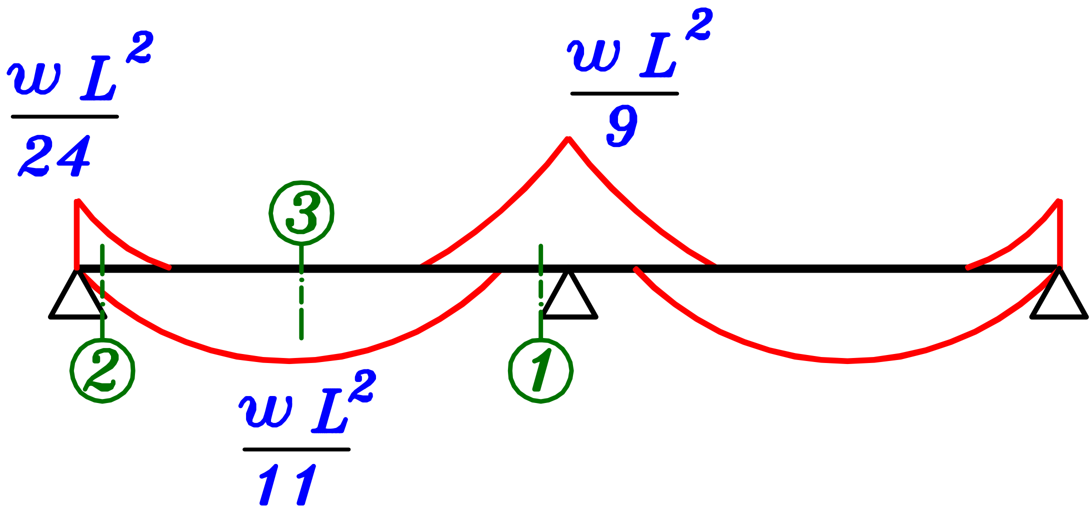


Sec. (2-2)

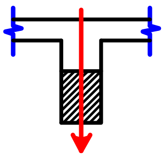


Sec. (1-1)

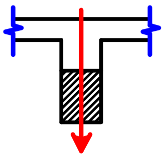
Continuous Beam Two spans.



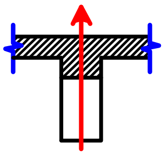
لتصميم الكمره ال *Continuous Two spans* يوجد ثلاث قطاعات



Sec. 1 عاده نبدأ بتصميم $\frac{wL^2}{9}$ و عاده يكون *R-sec.* نحدد له d , A_s



Sec. 2 ثم نصمم القطاع $\frac{wL^2}{24}$ و عاده يكون *R-sec.* نأخذ نفس d للقطاع الاول و نحدد A_s فقط



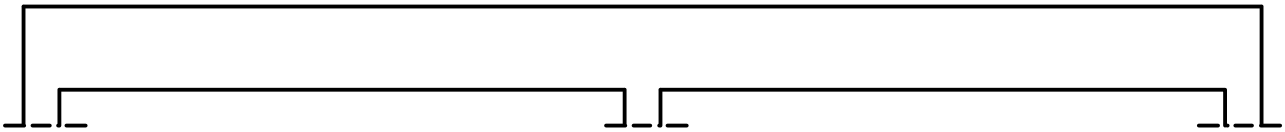
$K = 0.8$

Sec. 3 ثم نصمم القطاع $\frac{wL^2}{11}$ و عاده يكون *T-sec.* نأخذ نفس d للقطاع الاول و نحدد A_s فقط

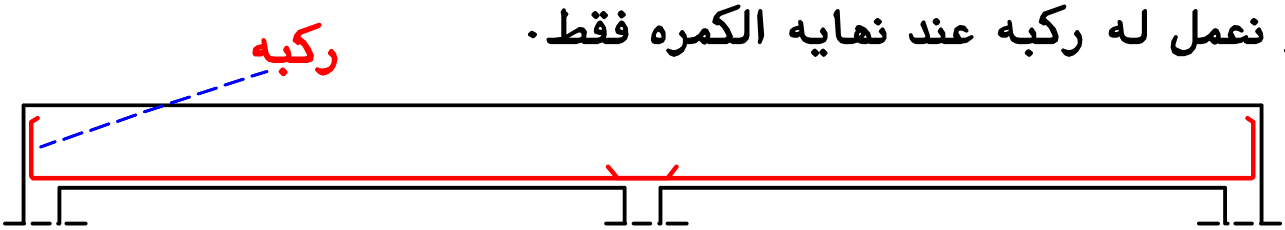
ملحوظه

صممنا القطاع $\frac{wL^2}{9}$ أولا . لانه *R-sec* و عليه أكبر *moment*

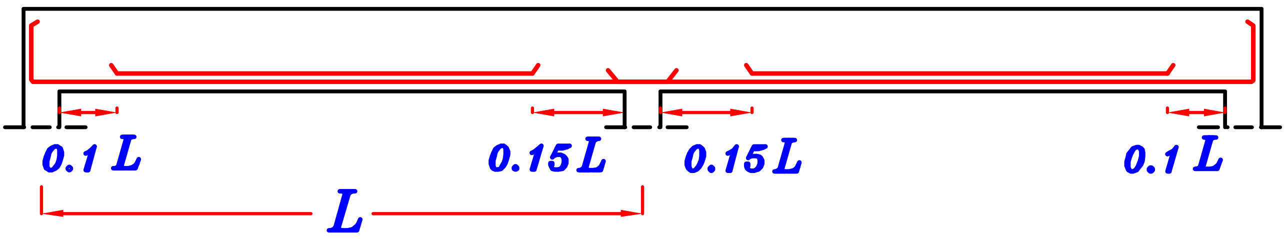
١- نرسم شكل الكمره بمقياس الرسم المطلوب



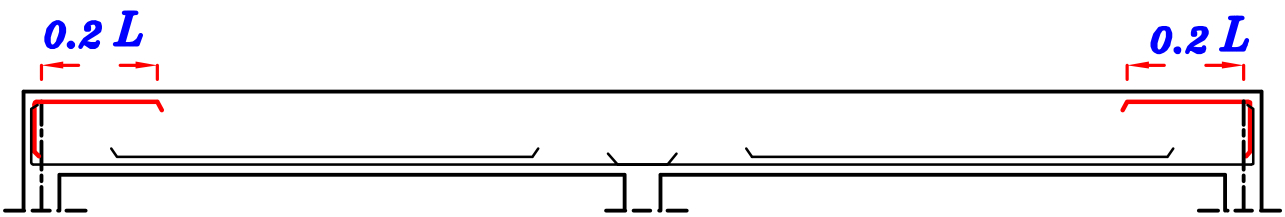
٢- نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره فقط.



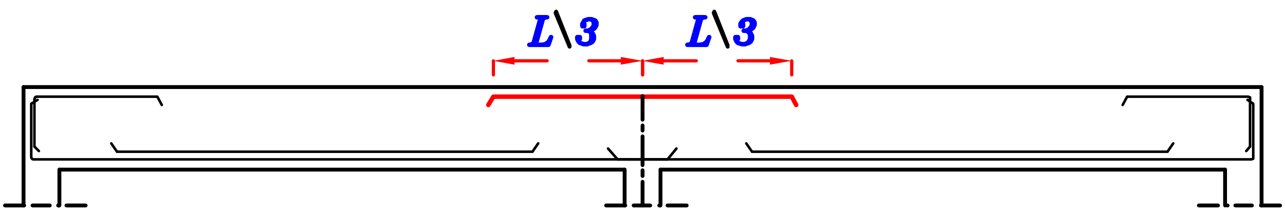
٣- باقى التسليح السفلى يقف عند مسافه $0.1\ L$ من وش العمود الذى فى الطرف. و يقف عند مسافه $0.15\ L$ من وش العمود الذى فى المنتصف.



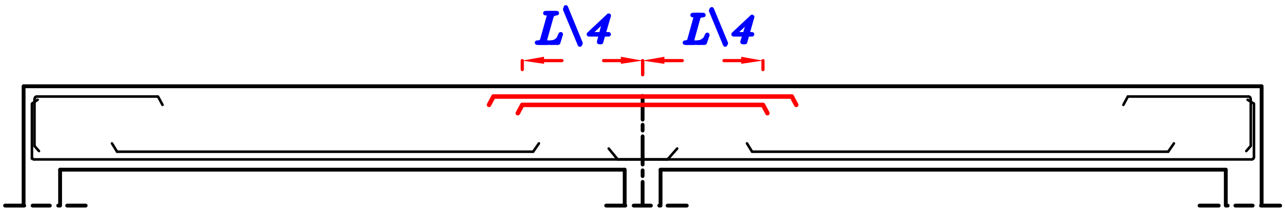
٤- نرسم التسليح الرئيسى للعزم $\frac{wL^2}{24}$ يعمل ركبه لاسفل عند نهايه الكمره و من أعلى يمتد حتى مسافه $0.2\ L$ من C.L. العمود.



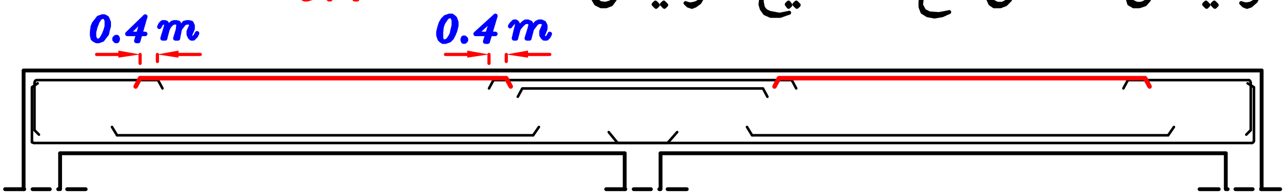
٥- نرسم نصف التسليح العلوى فوق العمود الداخلى و يقف عند مسافه $L\backslash 3$ من C.L. العمود الاوسط.



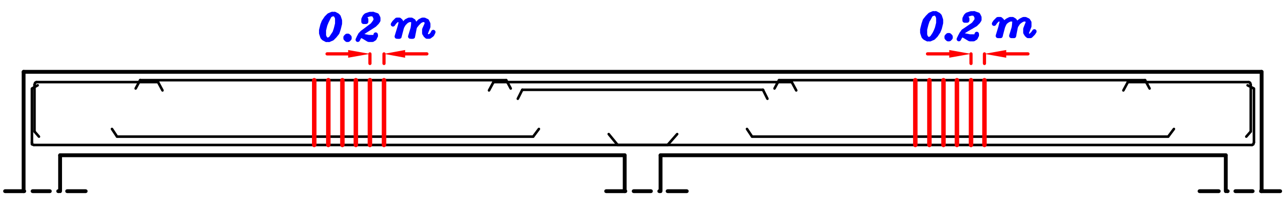
٦- نرسم النصف الاخر من التسليح العلوى فوق العمود الداخلى و يقف عند مسافه L\4 من C.L. العمود الاوسط.



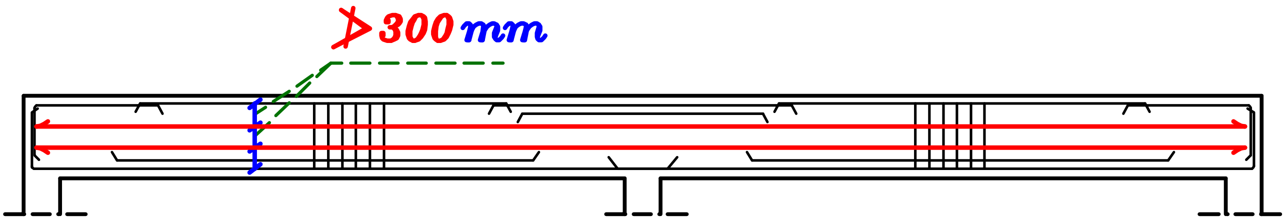
٧- فى المنطقه الباقيه نمد تسليح stirrup Hangers و يعمل تداخل مع التسليح الرئيسى مسافه 0.4 m



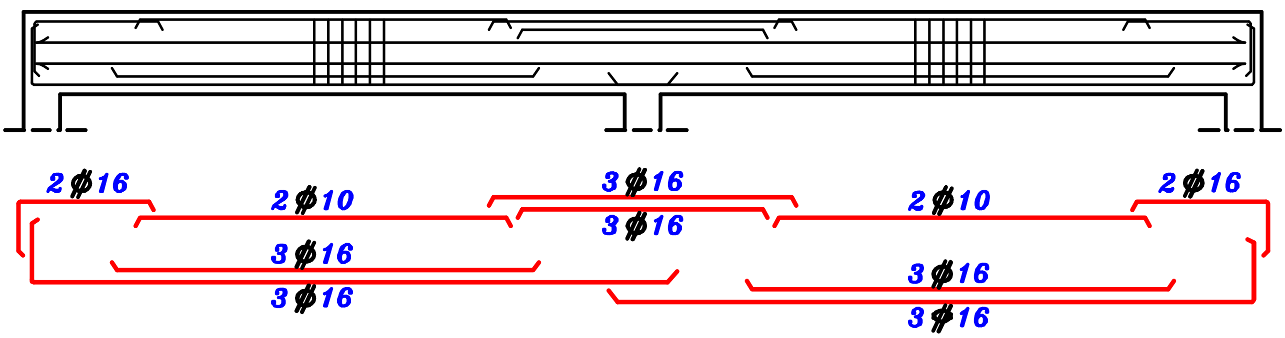
٨- نرسم تسليح الكانات عباره عن خطوط طوليه من الحديد الى الحديد فقط و تكون هذه الخطوط فى منتصف الكمره و تكون المسافات بينهم 0.2 m



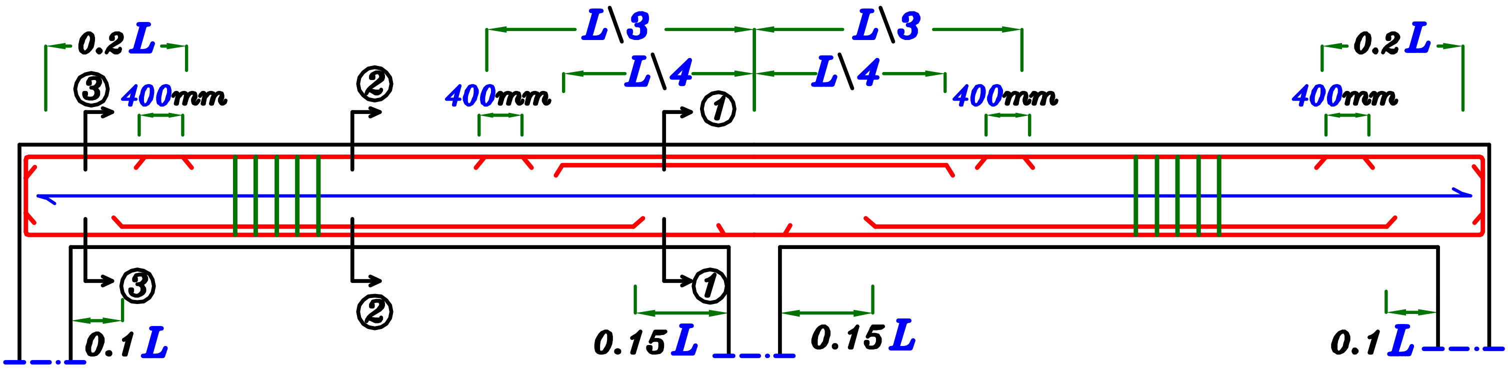
٩- اذا كان عمق الكمره أكبر من 700 mm نضع تسليح Shrinkage bars

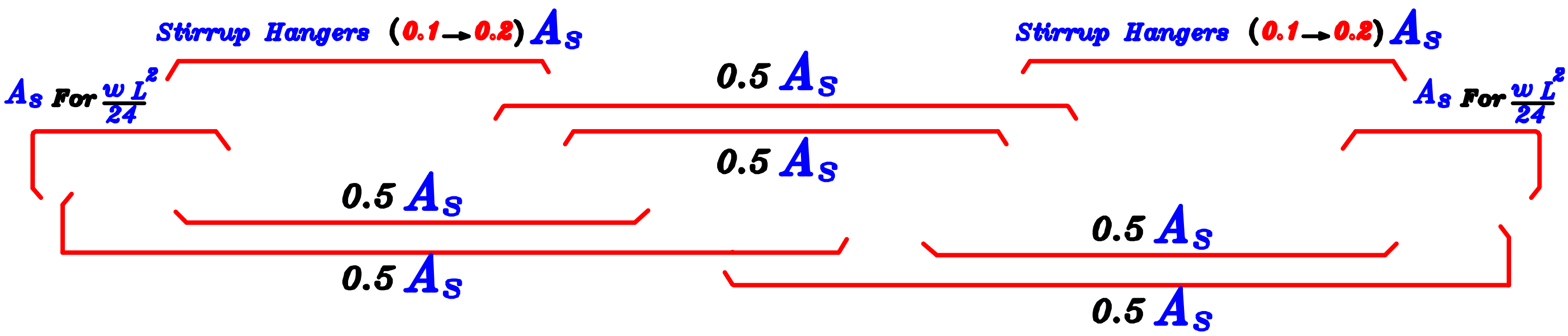


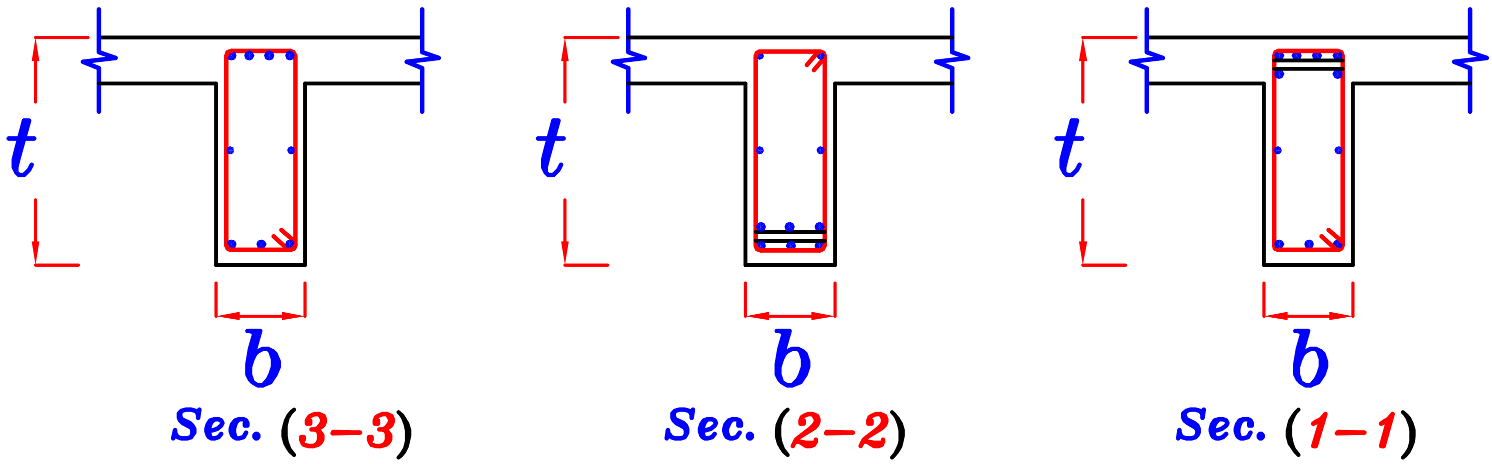
١٠- أسفل تسليح الكمره مباشره نرسم التفريد

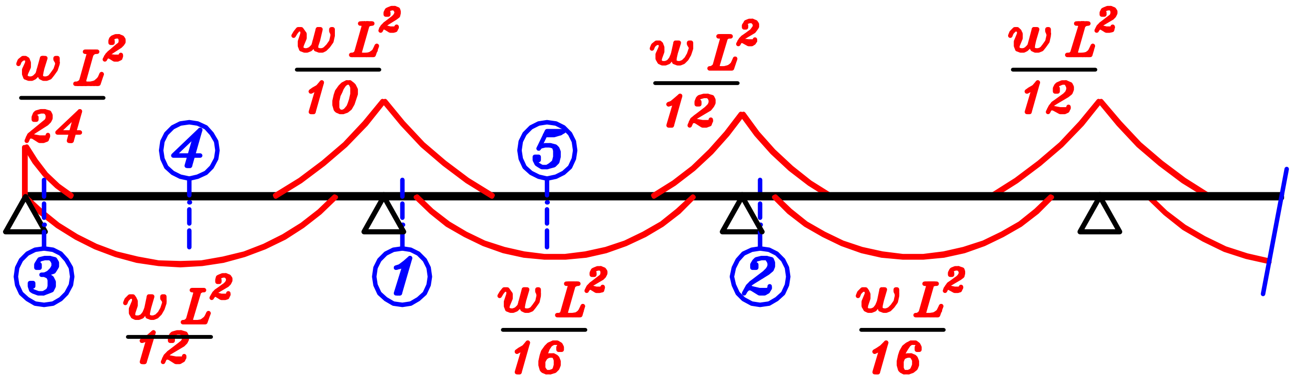


١١- نرسم تسليح الكمره فى cross sections بمقياس رسم أكبر

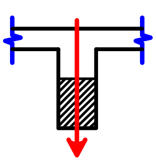

0.2 L
400mm
L\3
L\3
L\4
L\4
400mm
400mm
0.2 L
400mm
③
②
①
0.1 L
0.15 L
0.15 L
0.1 L


Stirrup Hangers (0.1→0.2) As
Stirrup Hangers (0.1→0.2) As
As For w L²/24
0.5 As
As For w L²/24
0.5 As
0.5 As
0.5 As
0.5 As
0.5 As
0.5 As

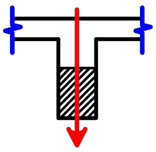

t
b
Sec. (3-3)
t
b
Sec. (2-2)
t
b
Sec. (1-1)



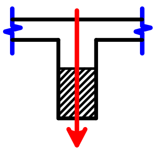
لتصميم الكمره ال Continous More than 2 Spans يوجد خمسه قطاعات

Sec. 1 

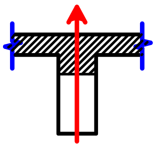
عاده نبدأ بتصميم $\frac{wL^2}{10}$ و عاده يكون R-sec.
نحدد له d , A_s

Sec. 2 

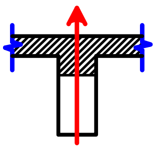
ثم نصمم القطاع $\frac{wL^2}{12}$ و عاده يكون R-sec.
نأخذ نفس d للقطاع الاول و نحدد A_s فقط

Sec. 3 

ثم نصمم القطاع $\frac{wL^2}{24}$ و عاده يكون R-sec.
نأخذ نفس d للقطاع الاول و نحدد A_s فقط

Sec. 4 

ثم نصمم القطاع $\frac{wL^2}{12}$ و عاده يكون T-sec.
نأخذ نفس d للقطاع الاول و نحدد A_s فقط $\boxed{K = 0.8}$

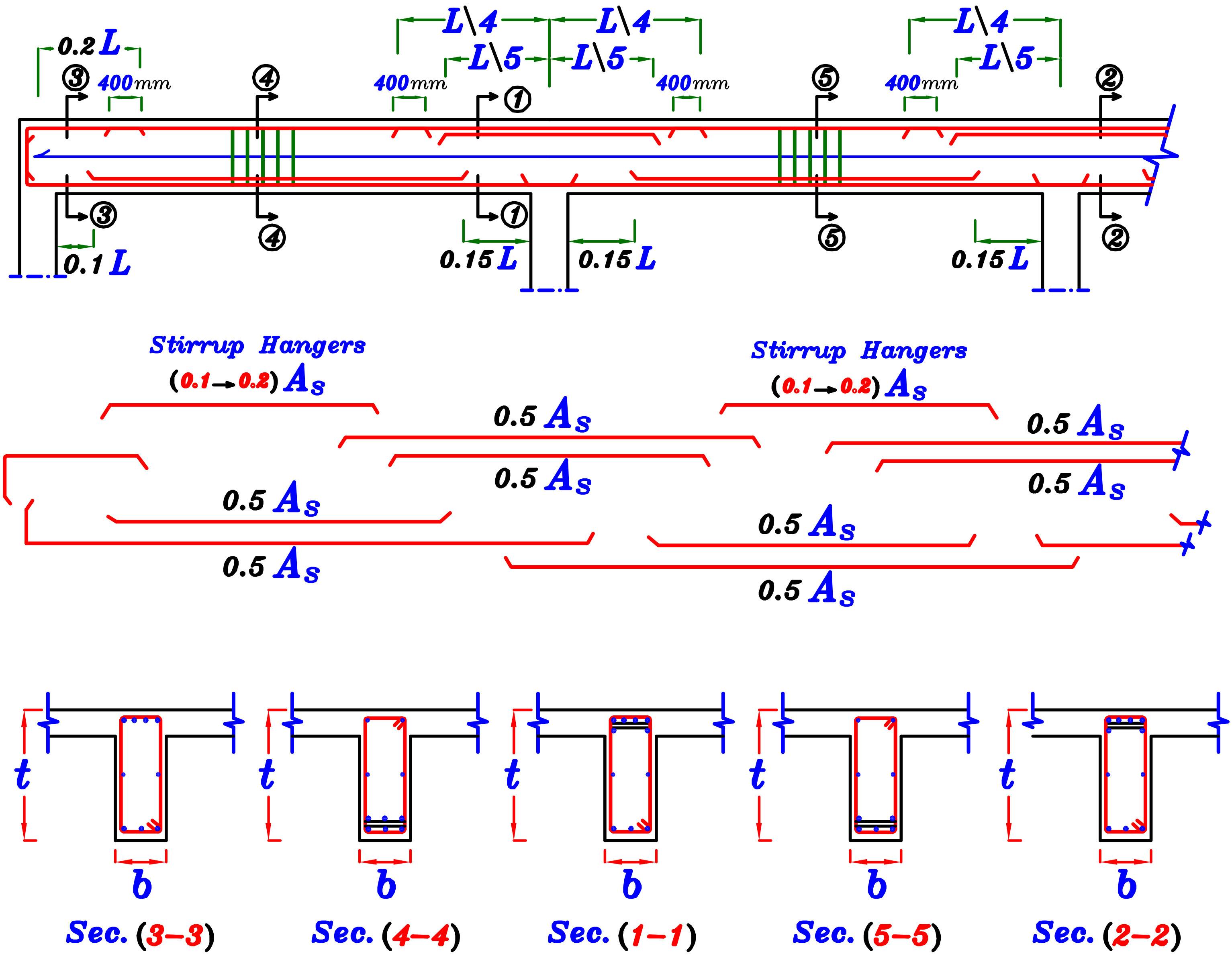
Sec. 5 

ثم نصمم القطاع $\frac{wL^2}{16}$ و عاده يكون T-sec.
نأخذ نفس d للقطاع الاول و نحدد A_s فقط $\boxed{K = 0.7}$

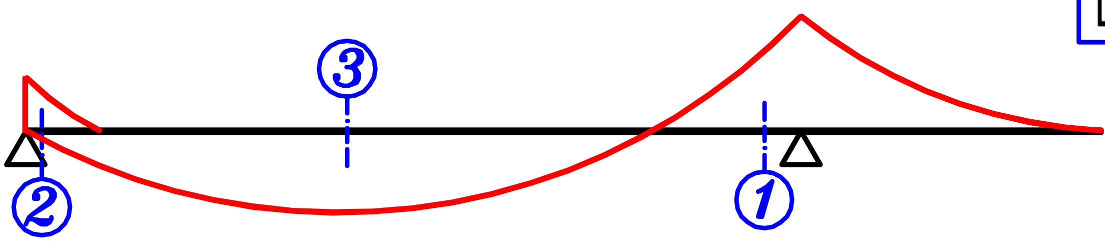
ملحوظه

صممنا القطاع $\frac{wL^2}{10}$ أولا. لانه R-sec و عليه أكبر moment

Continuous Beam (More than 2 Spans) Straight Bars.

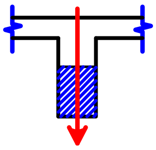


Beam with Cantilever.



لتصميم الكمره ال *Beam with Cantilever* يوجد ثلاث قطاعات

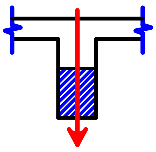
Sec. 1



عاده نبدأ بتصميم قطاع ال *cantilever* و عاده يكون *R-sec.*

نحدد له d , A_s

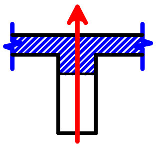
Sec. 2



ثم نصمم القطاع $\frac{wL^2}{24}$ و عاده يكون *R-sec.*

نأخذ نفس d للقطاع الاول و نحدد A_s فقط

Sec. 3



$\boxed{K = 0.8}$

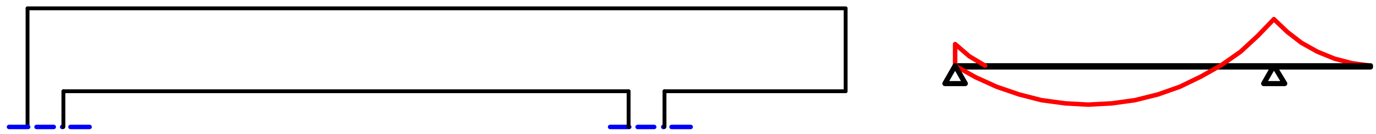
ثم نصمم القطاع الذى فى المنتصف و عاده يكون *T-sec.*

نأخذ نفس d للقطاع الاول و نحدد A_s فقط

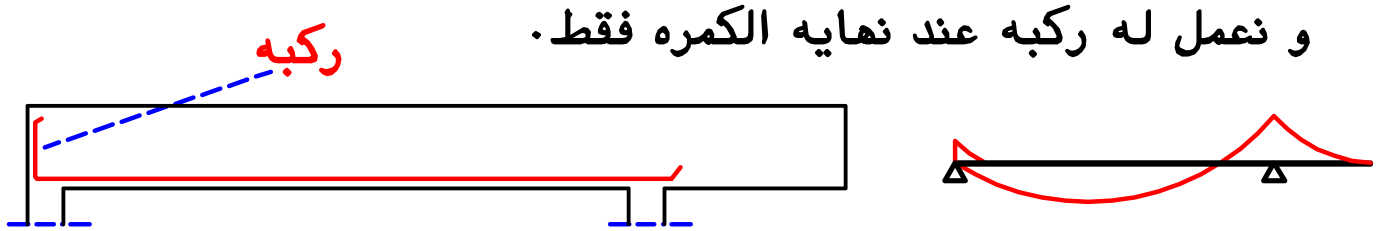
ملحوظه

صممنا قطاع ال *cantilever* أولاً لانه *R-sec* و عليه أكبر *moment*

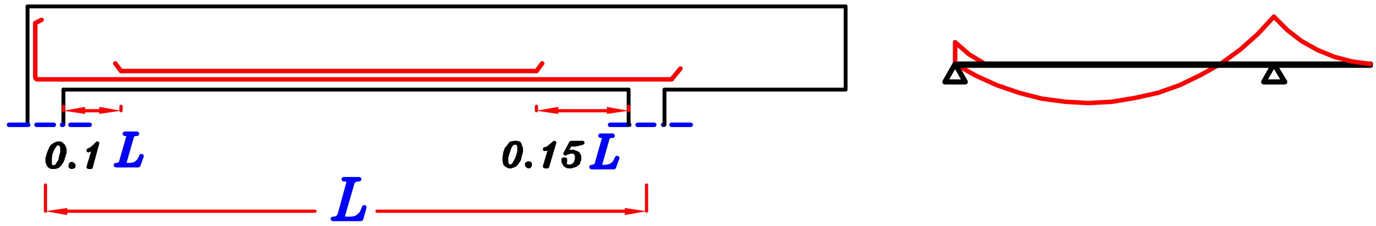
١ـ نرسم شكل الكمره بمقياس الرسم المطلوب



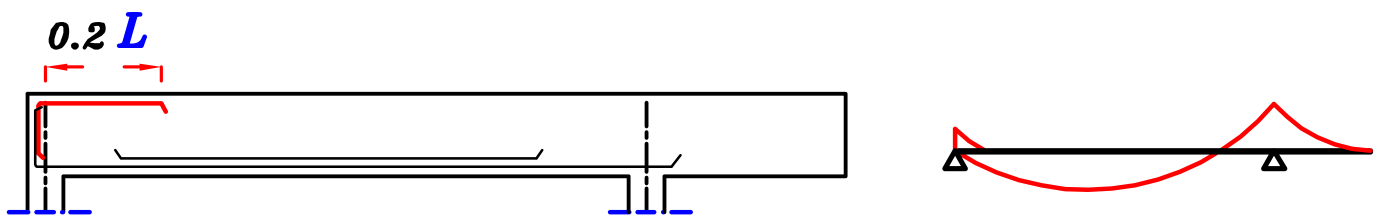
٢ـ نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره فقط.



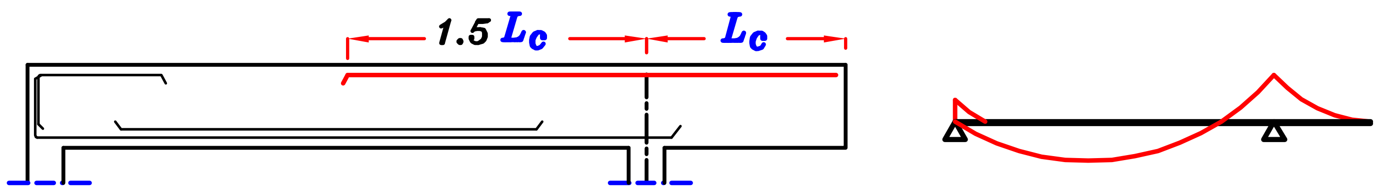
٣ـ باقى التسليح السفلى يقف عند مسافه $0.1\ L$ من وش العمود الذى فى الطرف.
و يقف عند مسافه $0.15\ L$ من وش العمود الذى عند ال cantilever.



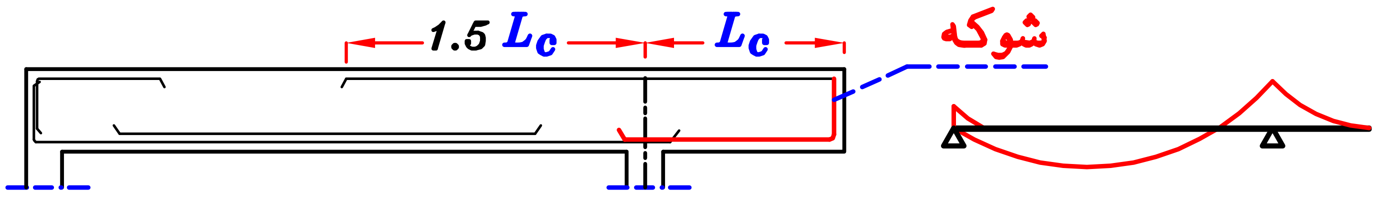
٤ـ نرسم التسليح الرئيسى للعزم $\frac{wL^2}{24}$ يعمل ركبه لاسفل عند نهايه الكمره و من أعلى يمتد حتى مسافه $0.2\ L$ من C.L. العمود.



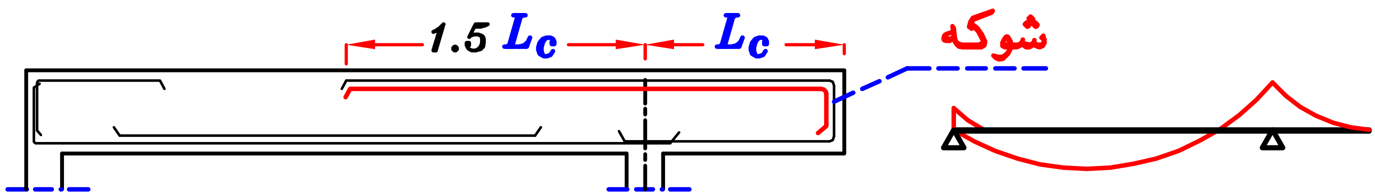
٥ـ نرسم التسليح العلوى لل cantilever بحيث يمتد داخل الكمره مسافه $1.5\ L_c$ من C.L. العمود الاوسط.



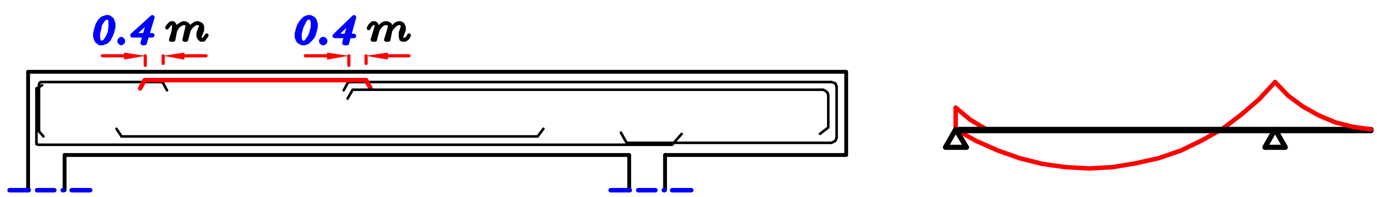
٦- نكمل باقى تسليح الـ *cantilever* لاسفل و يكمل حتى وش العمود
و يسمى التسليح الزياده **شوكه**
و فائده الشوكه هو تقليل الـ *Deflection* لل *cantilever*



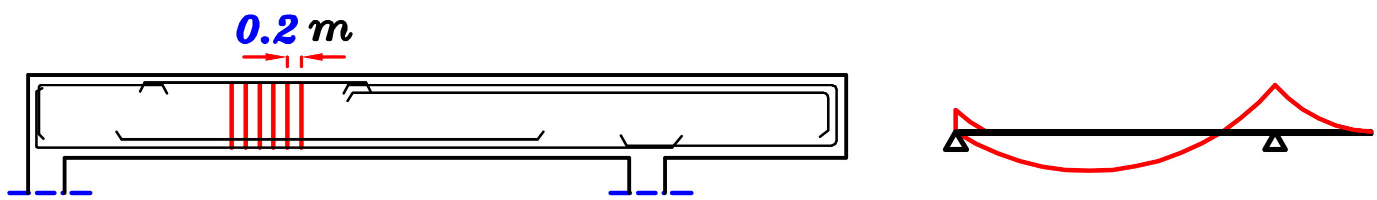
٧- ممكن اخذ نصف تسليح الـ *cantilever* بحيث يمتد مسافه $1.5\ L_c$ من *C.L.* العمود الاوسط و تمتد ركبه فقط عند طرف الـ*cantilever* .



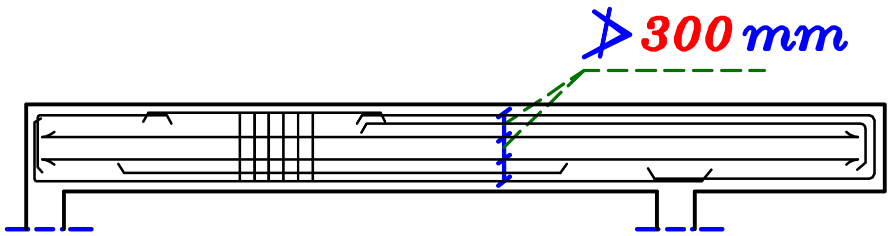
٨- فى المنطقه الباقيه نمد تسليح *Hangers stirrup*
و يعمل تداخل مع التسليح الرئيسى مسافه $0.4\ m$

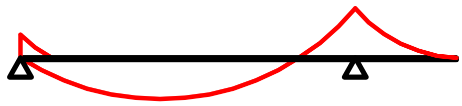


٩- نرسم تسليح الكانات عباره عن خطوط طوليه من الحديد الى الحديد فقط
و تكون هذه الخطوط فى منتصف الكمره و تكون المسافات بينهم $0.2\ m$

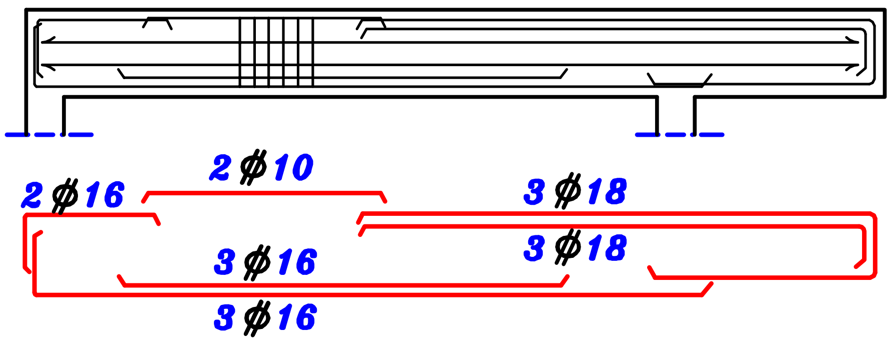


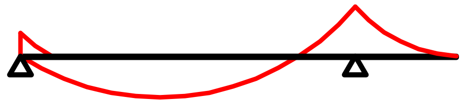
١٠- اذا كان عمق الكمره أكبر من 700 mm نضع تسليح Shrinkage bars





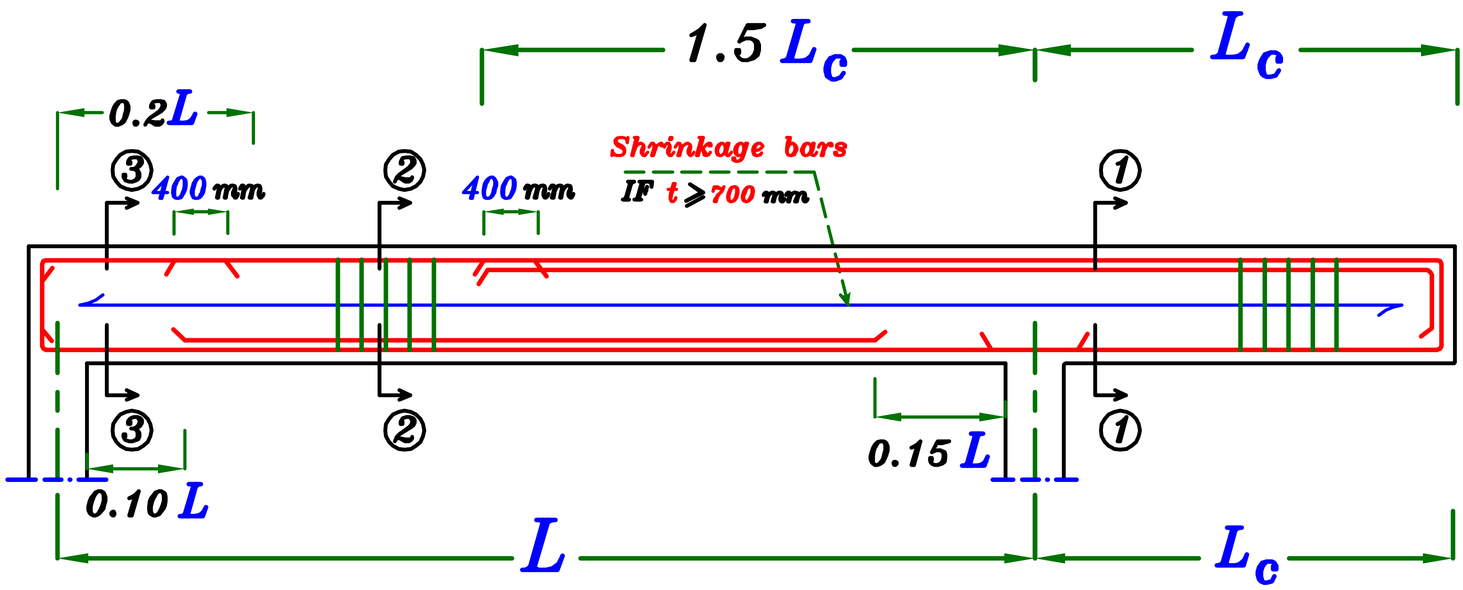
١١- أسفل تسليح الكمره مباشره نرسم التفريد

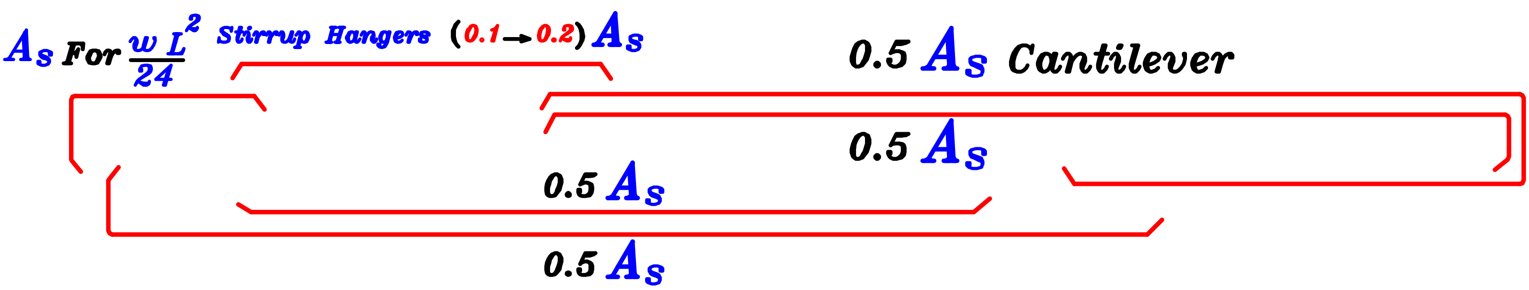


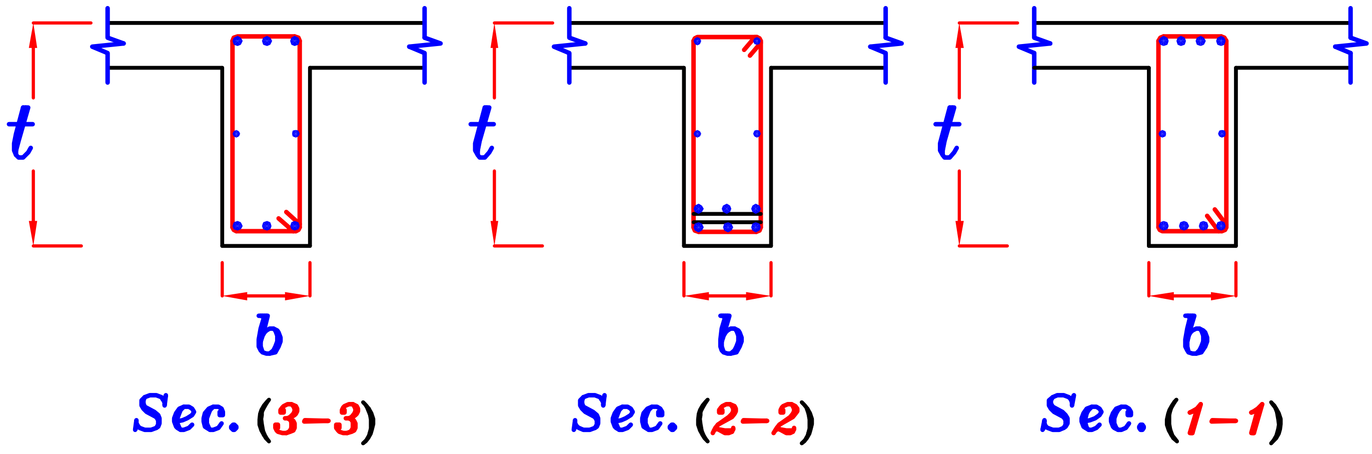


١٢- نرسم تسليح الكمره فى cross sections بمقياس رسم أكبر

Beam with Cantilever.





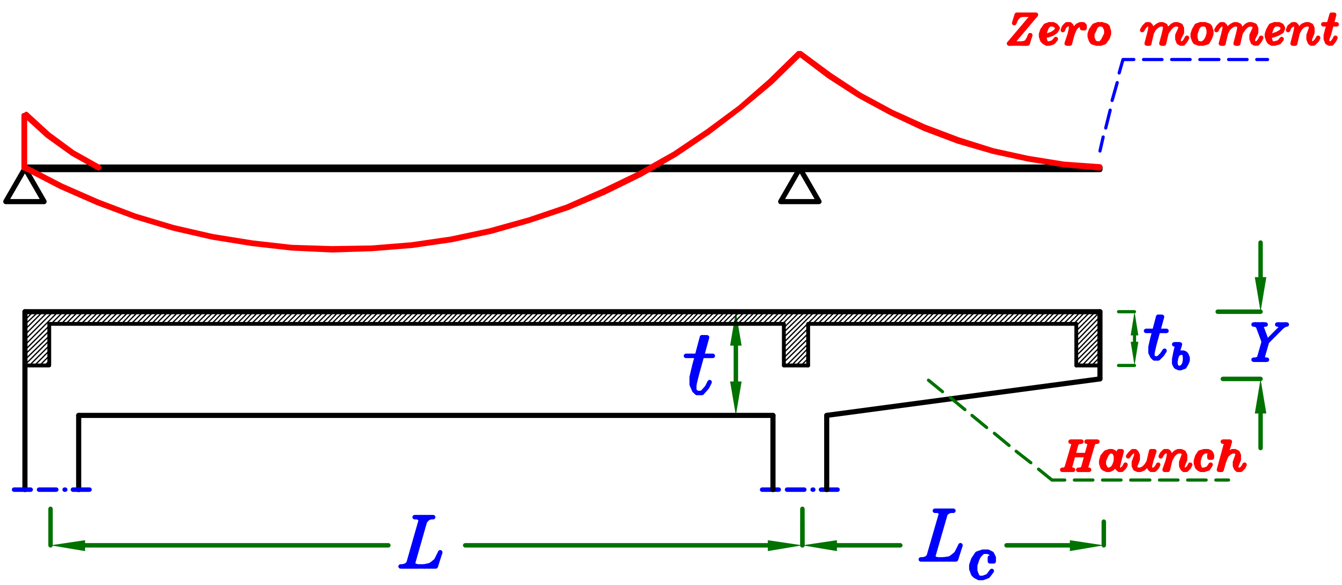


IF we use a Haunch in the cantilever.

ممكن للتوفير تقليل عمق الخرسانه عند طرف ال cantilever

لان العزم عند طرف ال cantilever يساوى zero

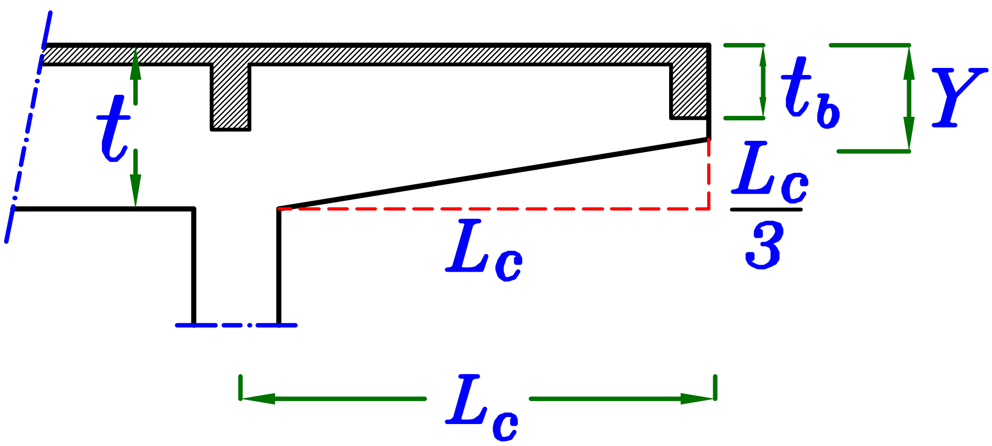
و فى هذه الحاله نسمى الكابولى Haunch

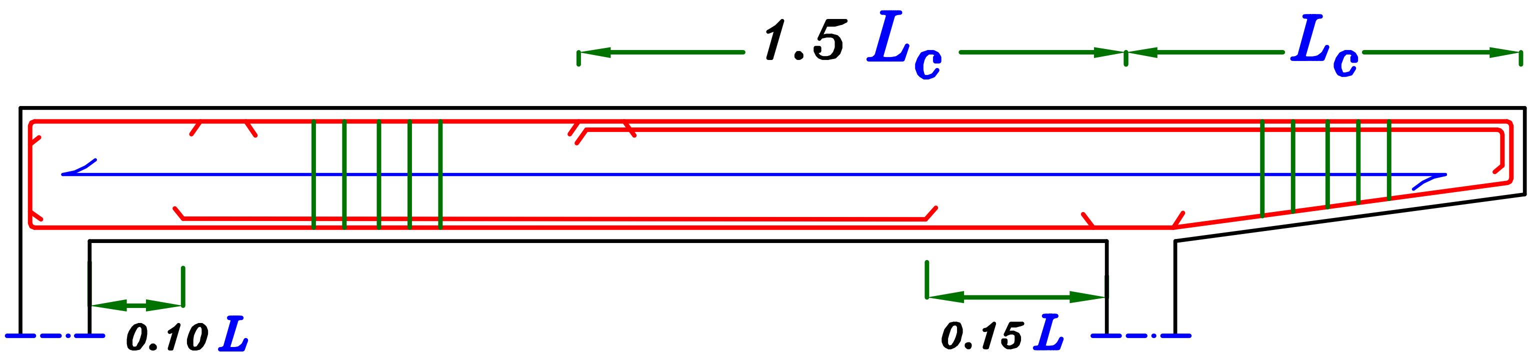


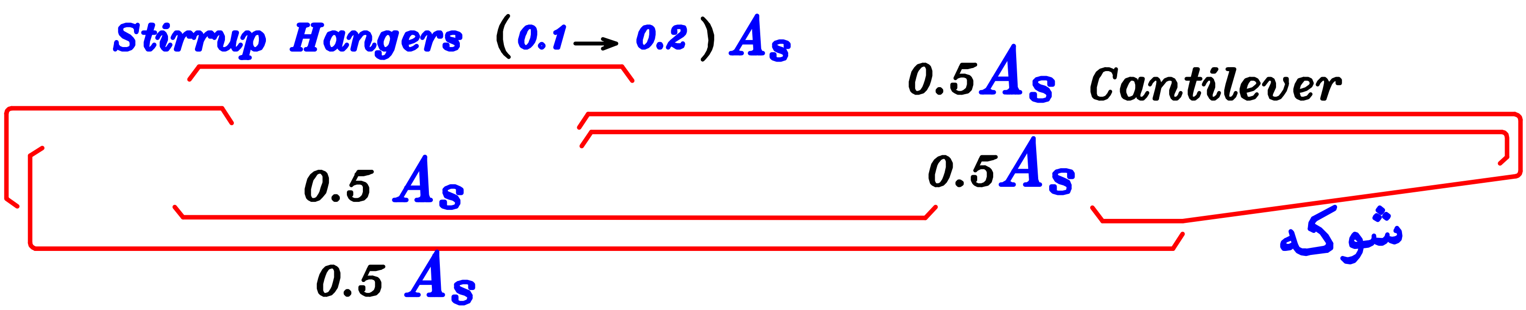
و لرسم ال Haunch يجب أولا تحديد أقل عمق لل Haunch و يسمى Y

$Y =$ الأكبر من:

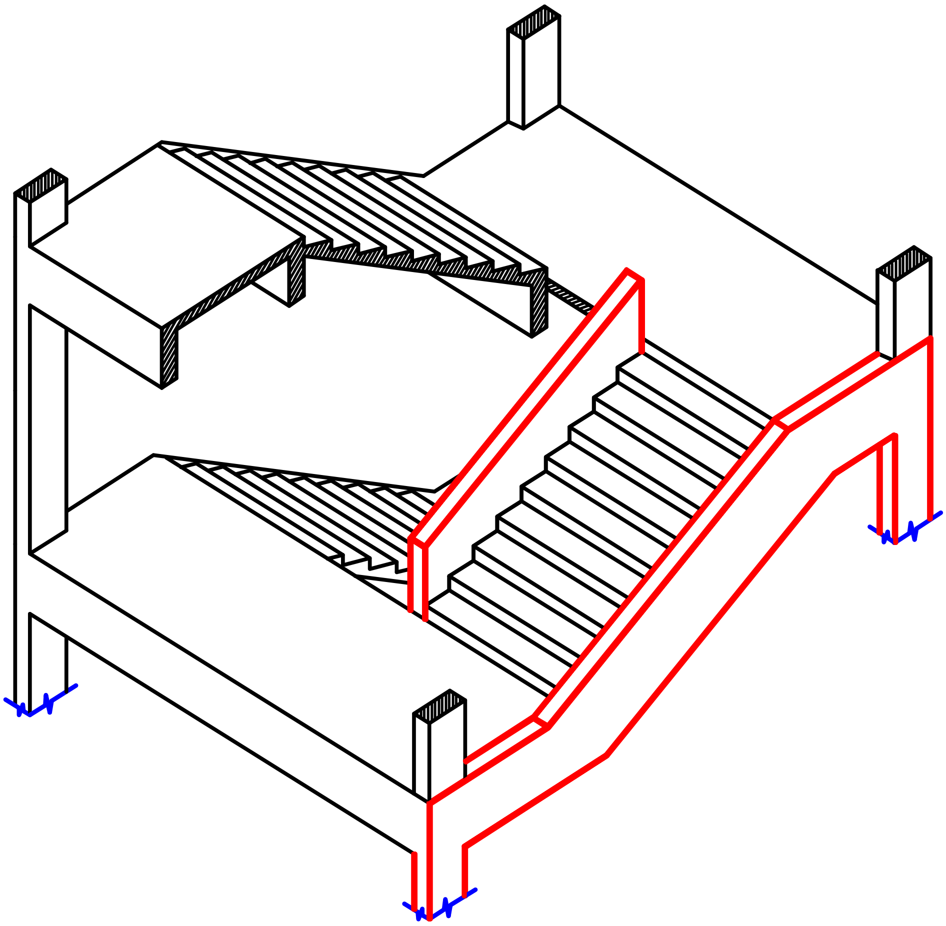
- $\frac{t}{2}$ نصف العمق الاصلى للكمره
- t_b عمق الكمره المحمولة على طرف ال cantilever
- $t - \frac{L_c}{3}$ ميل ال Haunch لا يزيد عن ١ : ٣ (رأسى : أفقى)




1.5 L_c
L_c
0.10 L
0.15 L

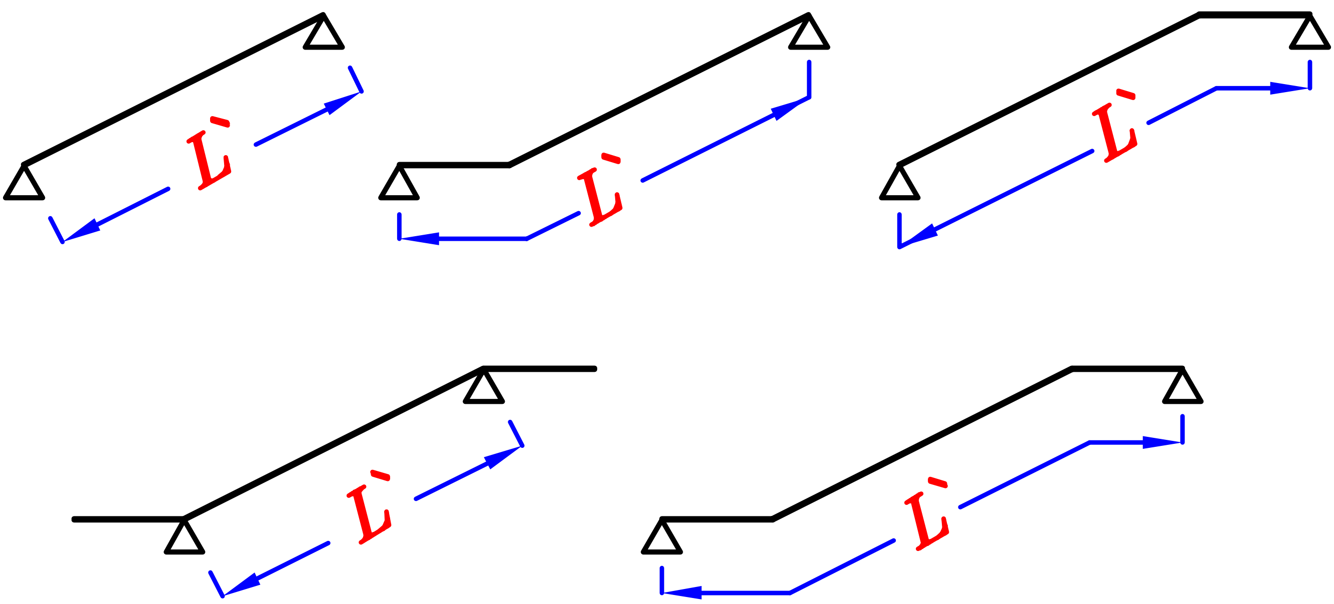

Stirrup Hangers (0.1 → 0.2) A_s
0.5A_s Cantilever
0.5 A_s
0.5A_s
شوكه
0.5 A_s

عاده توجد الكمرات المائله فى السلالم .

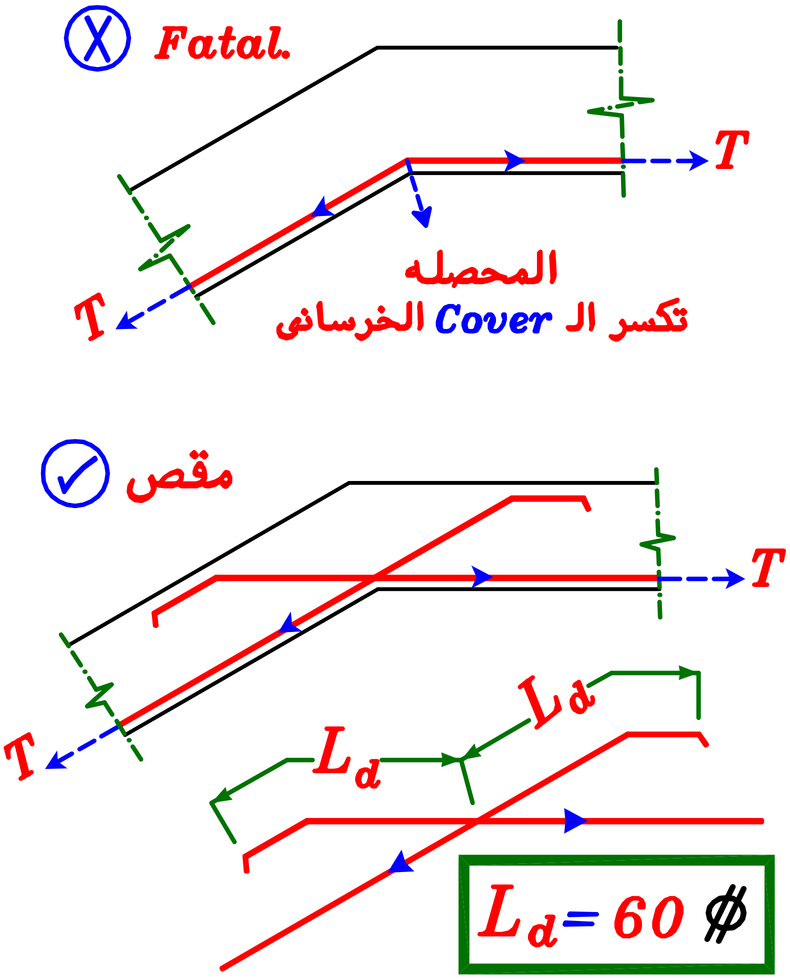


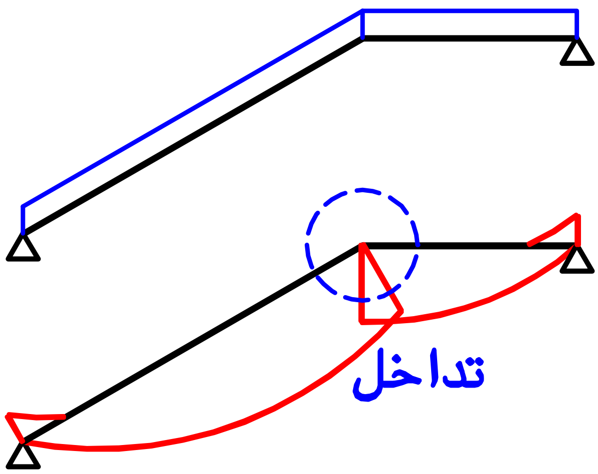
تسليح الكمرات المائله مثل الكمرات الافقيه مع الاختلاف فى :

١ ـ فى الكمرات المائله نحسب على الاطوال الحقيقيه ($L`$) .

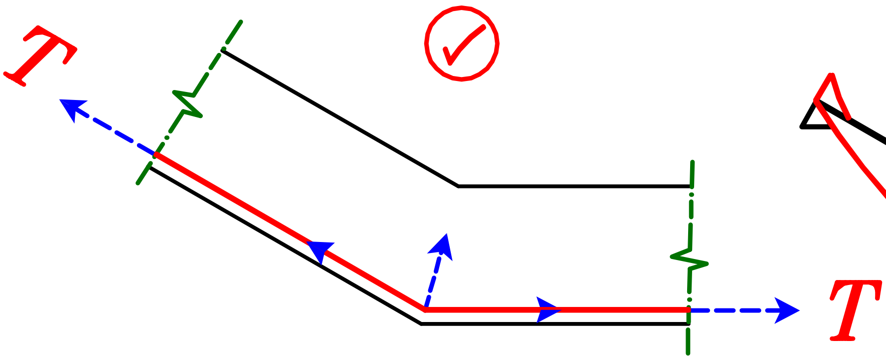


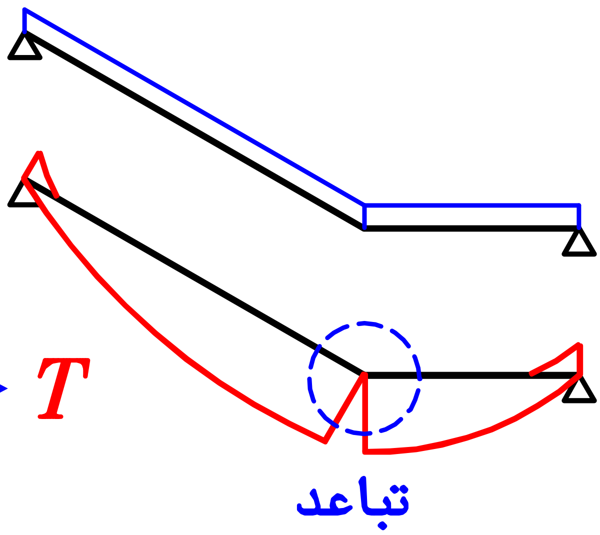
٢ـ إذا حدث تداخل فى العزوم يجب عمل مقص فى التسليح أو ممكن عمل فيونكه .





٣ـ إذا حدث تباعد فى العزوم يجب أن نكمل حديد التسليح .

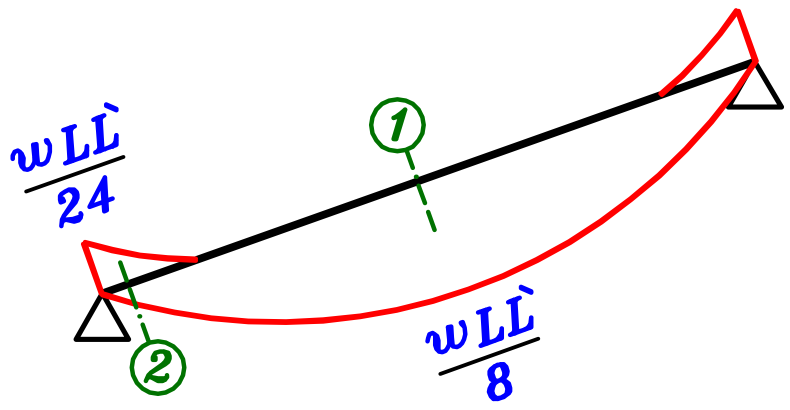




لا يوجد خوف على الخرسانه

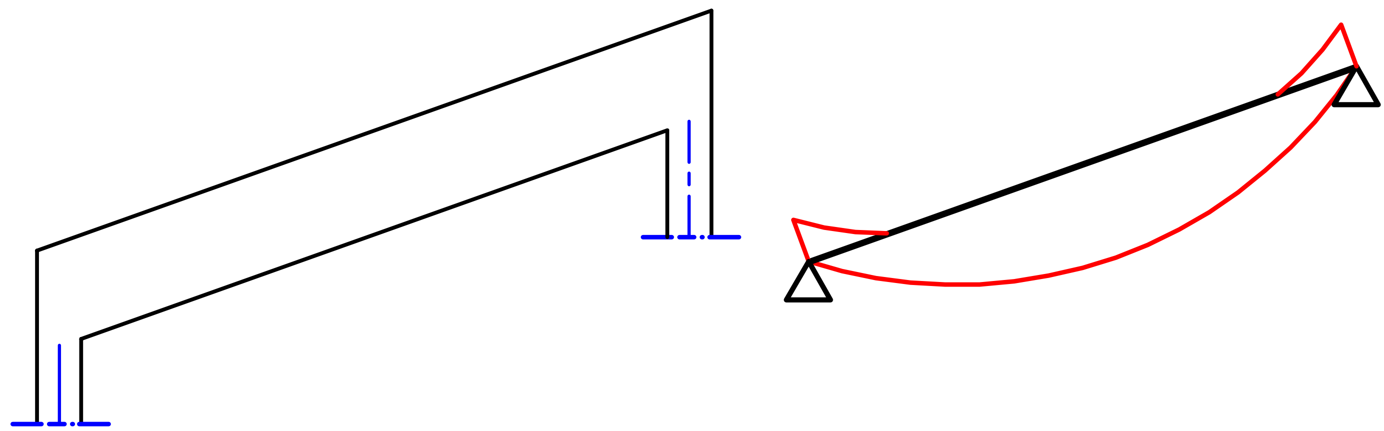
لأن سمكها كبير .

Inclined Simple Beam.

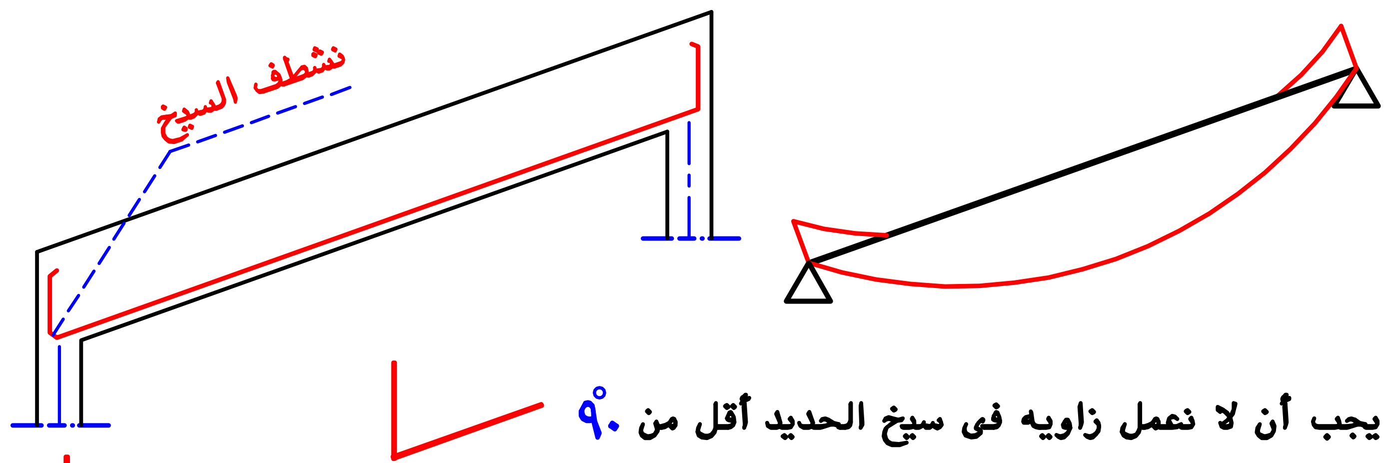


خطوات رسم تسليح كمره Simple فى ال elevation

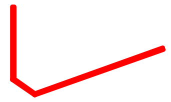
١- نرسم شكل الكمره بمقياس الرسم المطلوب



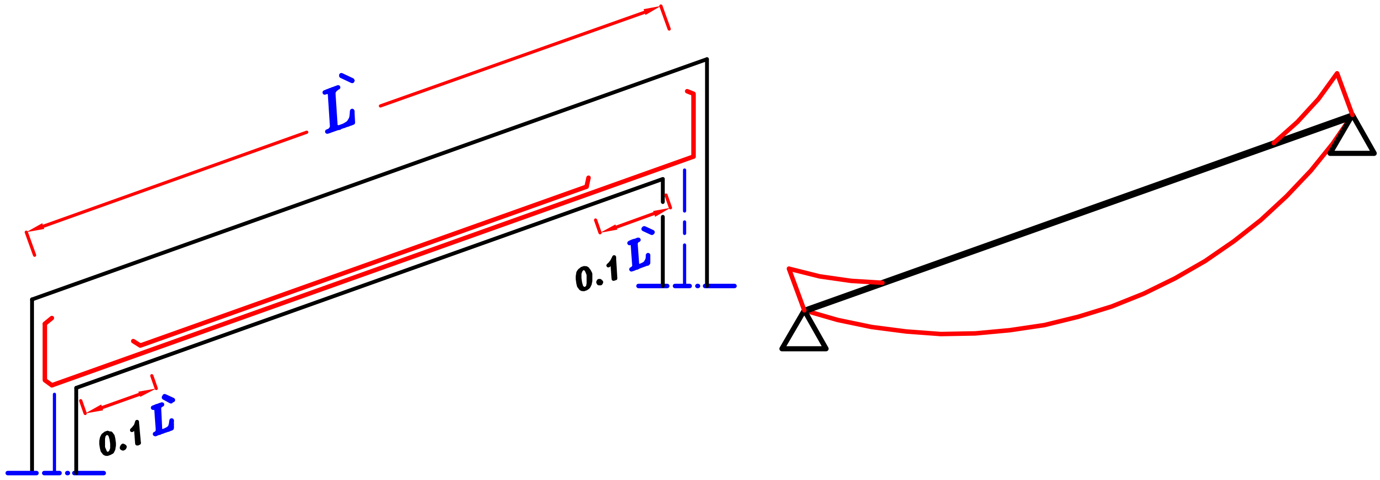
٢- نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره .



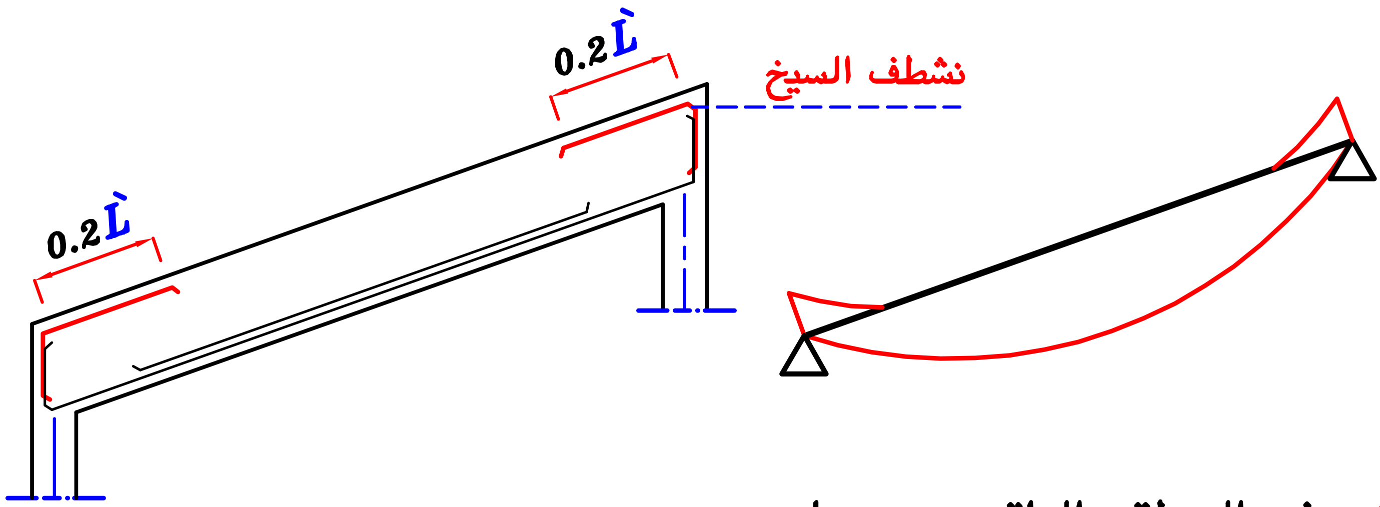
يجب أن لا نعمل زاويه فى سيخ الحديد أقل من ٩٠

اذا اضطررنا أن نحنى السيخ بزاويه أقل من ٩٠ نشطف السيخ كما بالشكل 

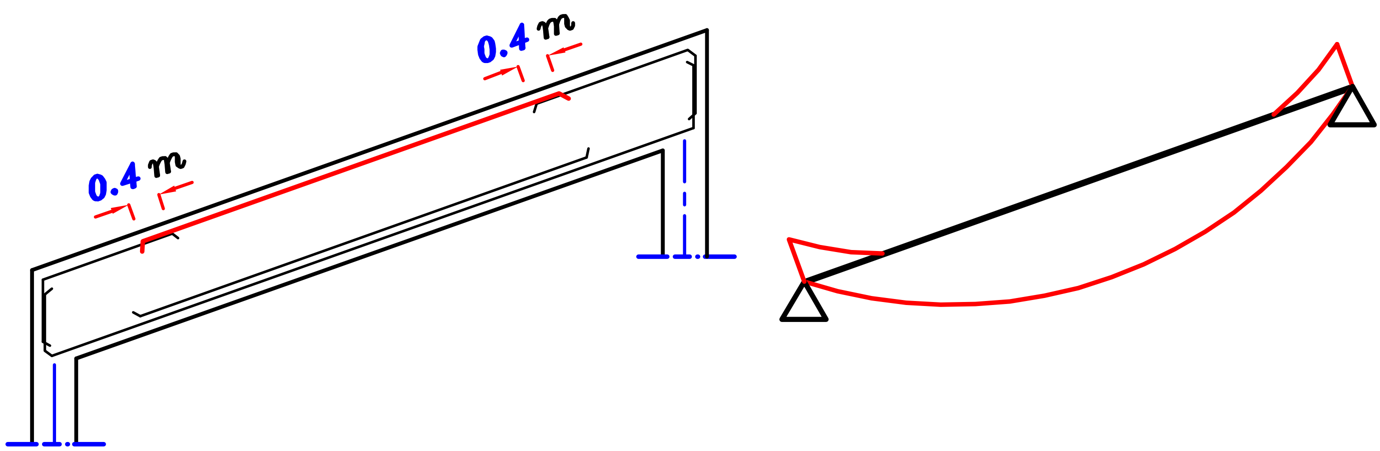
٣- باقى التسليح السفلى حتى مسافه $0.1\,L`$ من وش العمود الداخلى .
حيث $L`$ هى الطول الحقيقى من $C.L.$ الاعمده .



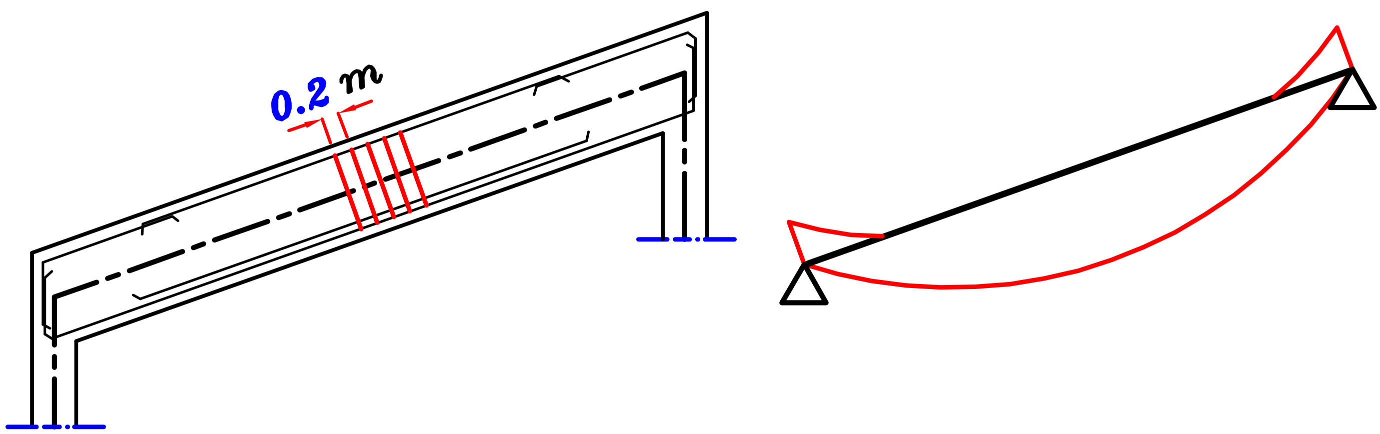
٤- نرسم التسليح الرئيسى للعزم $\frac{wLL`}{24}$ يعمل ركبه لاسفل عند نهايه الكمره
و من أعلى يمتد حتى مسافه $0.2\,L`$ من $C.L.$ العمود .



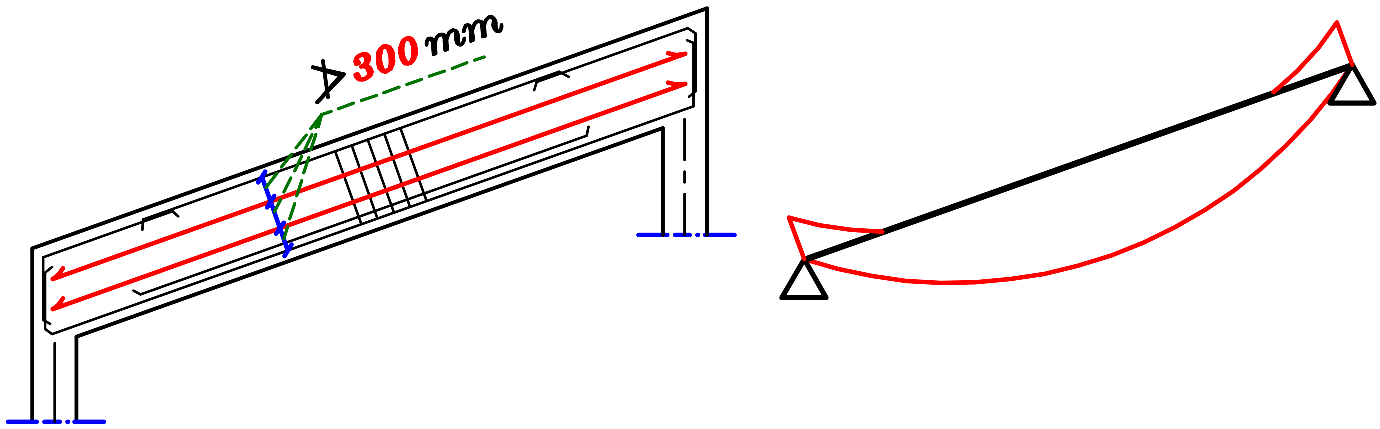
٥- فى المنطقه الباقيه نمد تسليح *Hangers stirrup*
و يعمل تداخل مع التسليح الرئيسى مسافه $0.4\ m$ على الطول المائل .



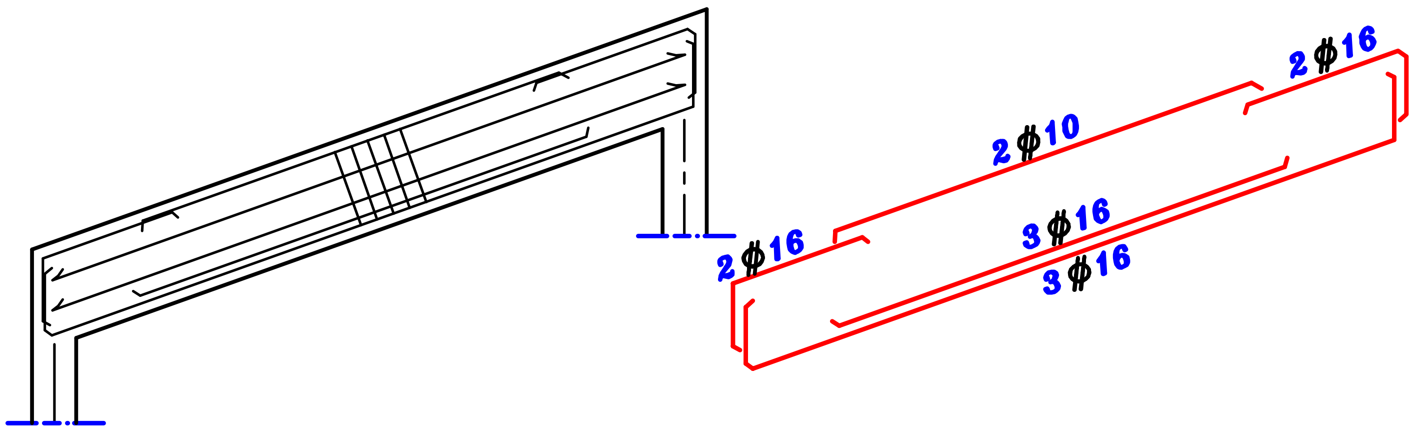
٦ـ نرسم الكانات عموديه على ال C.L الكمره .



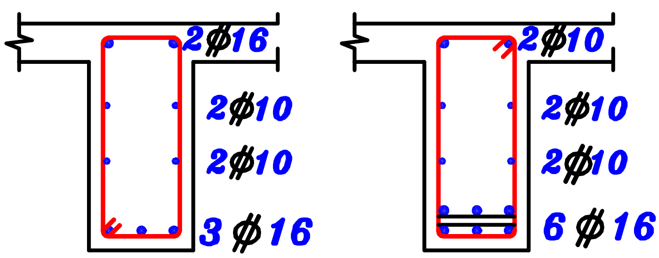
٧ـ اذا كان عمق الكمره أكبر من 700 mm نضع Shrinkage bars و تكون موازيه لـ C.L الكمره .



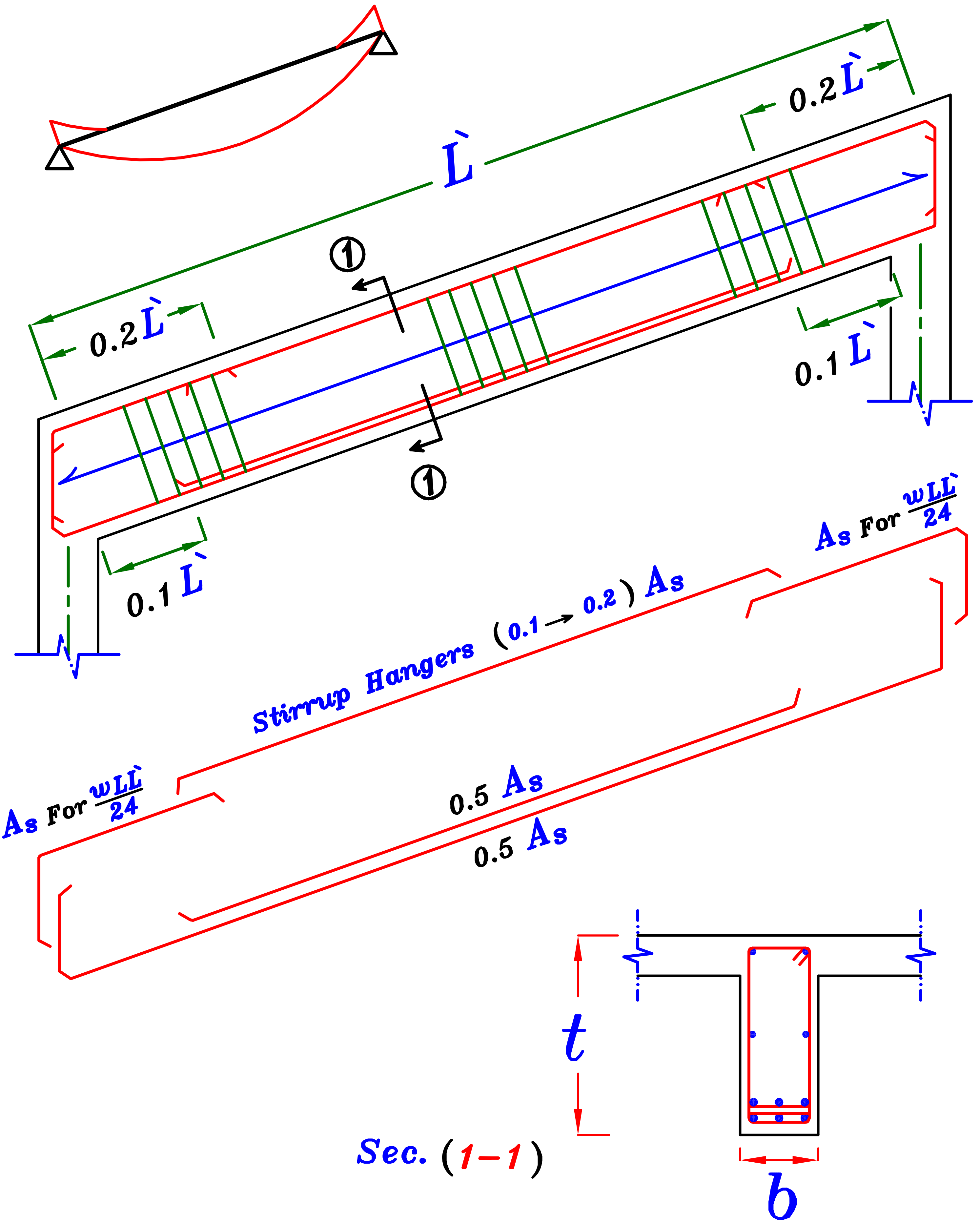
٨ـ أسفل تسليح الكمره مباشره نرسم التفريد و يكون بنفس مقياس رسم الكمره



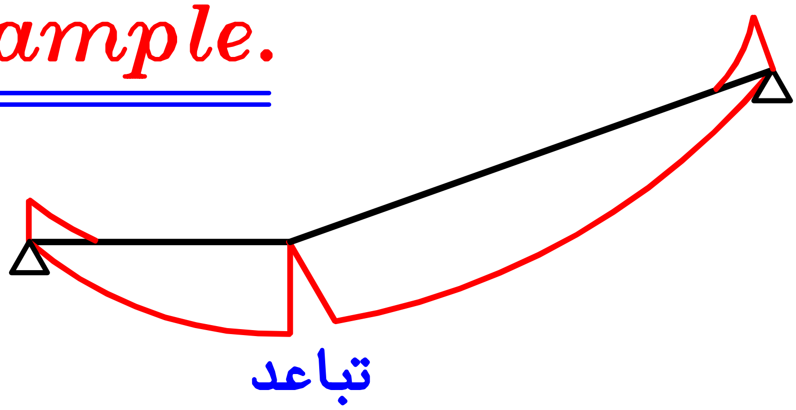
٩ـ نرسم تسليح الكمره فى cross sections بمقياس رسم أكبر



Inclined Simple Beam.

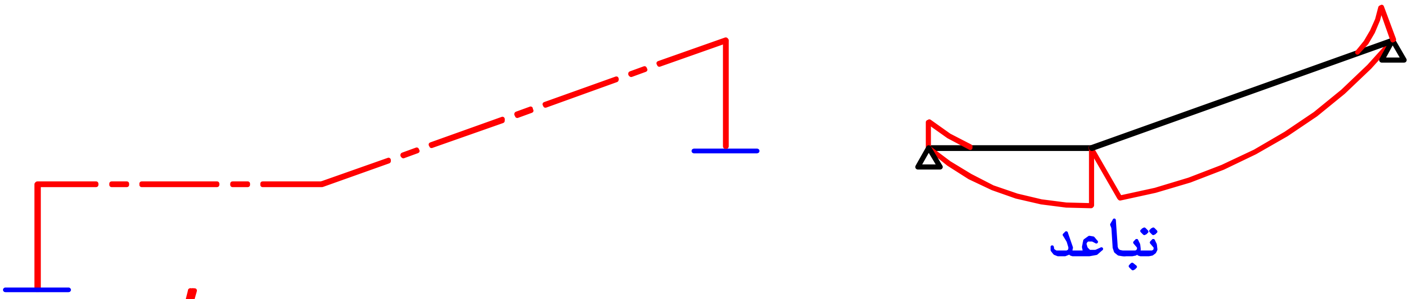


Example.

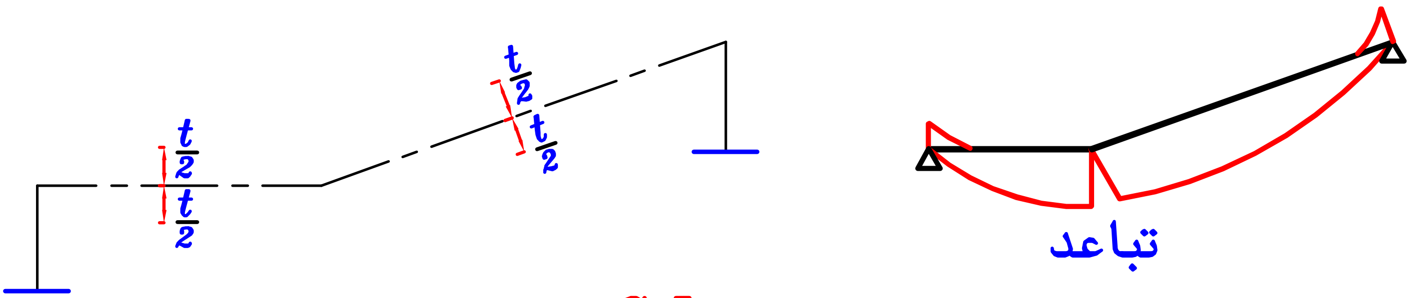


خطوات رسم تسليح الكمره فى ال elevation

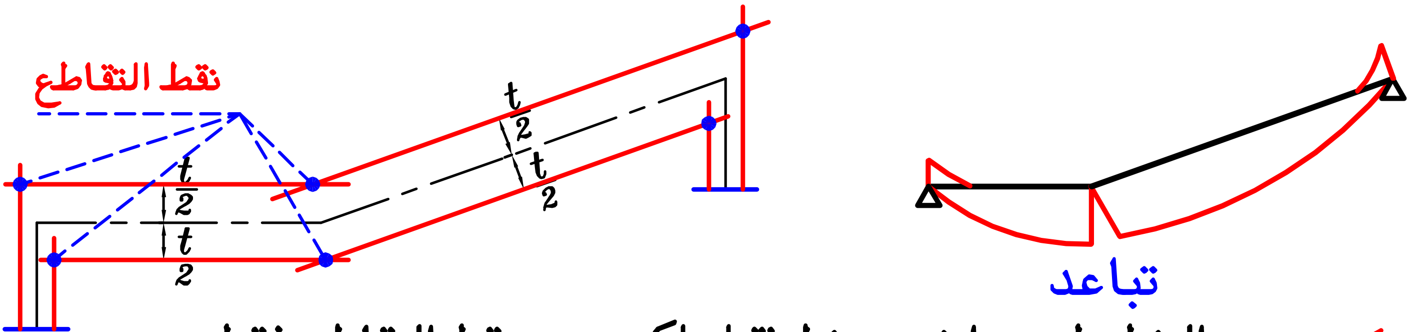
١- نرسم C.L. بمقياس الرسم المطلوب



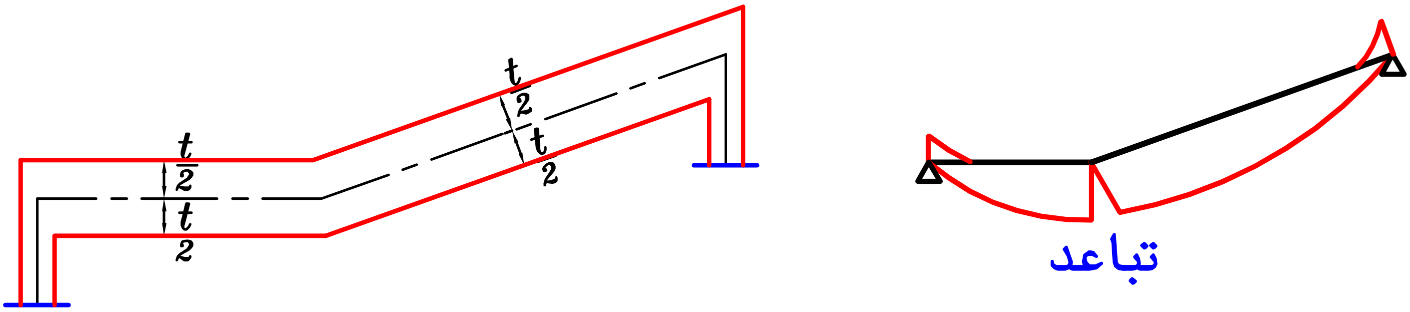
٢- نوقع التخانه للكمره عموديه دائما على ال C.L. بقيمه $\frac{t}{2}$



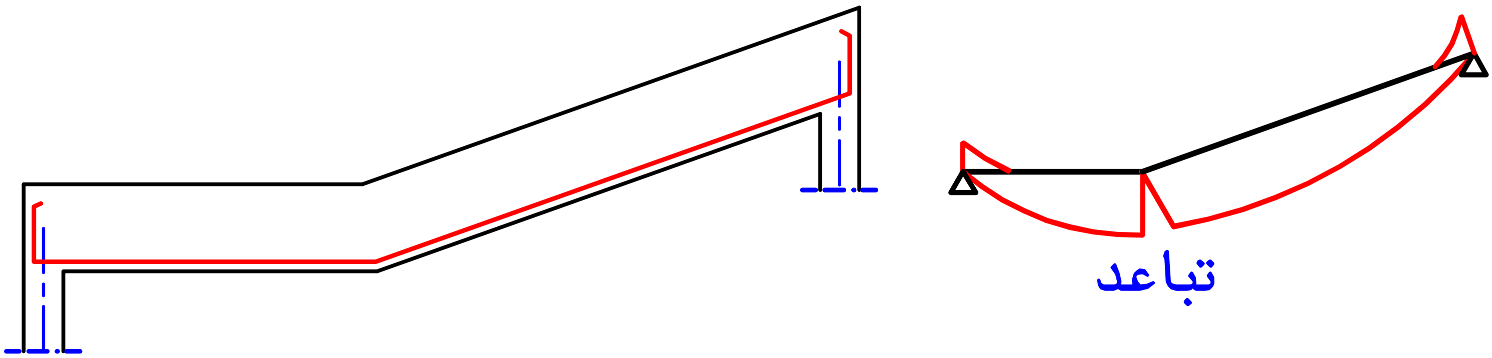
٣- نوصل خطوط خفيفه موازيه لل C.L. حتى نحدد نقط التقاطع



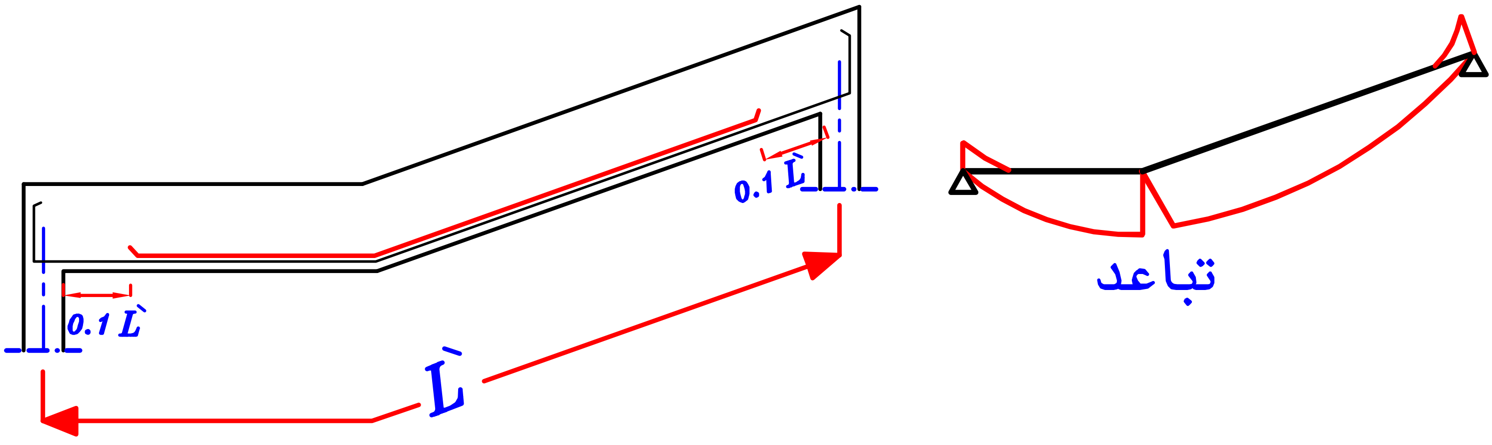
٤- نرسم الخطوط مره اخرى بخط ثقيل لكن حتى نقط التقاطع فقط.



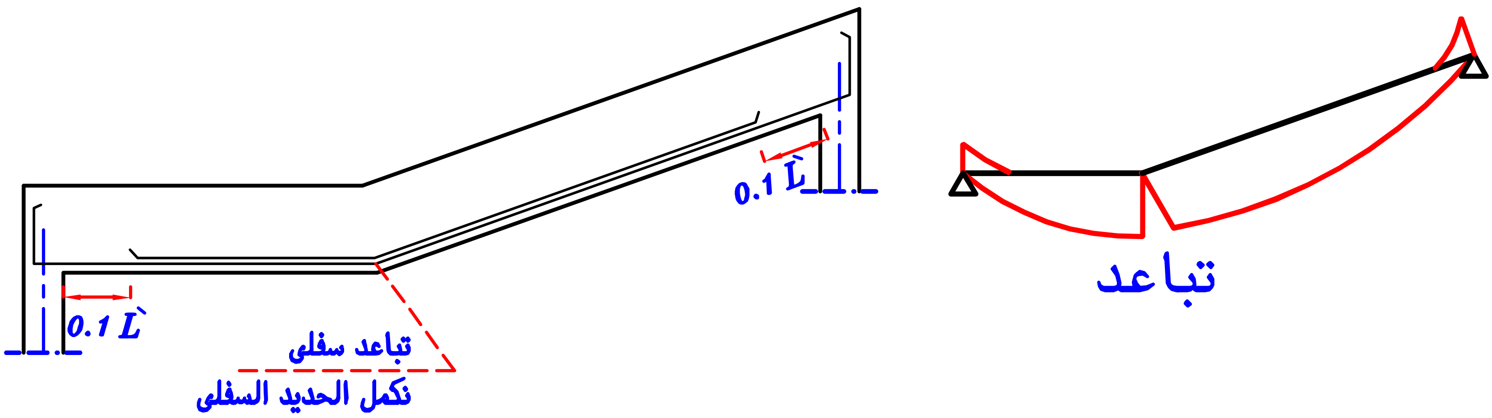
٥- نرسم نصف التسليح السفلى **(أو أكثر)** من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره .



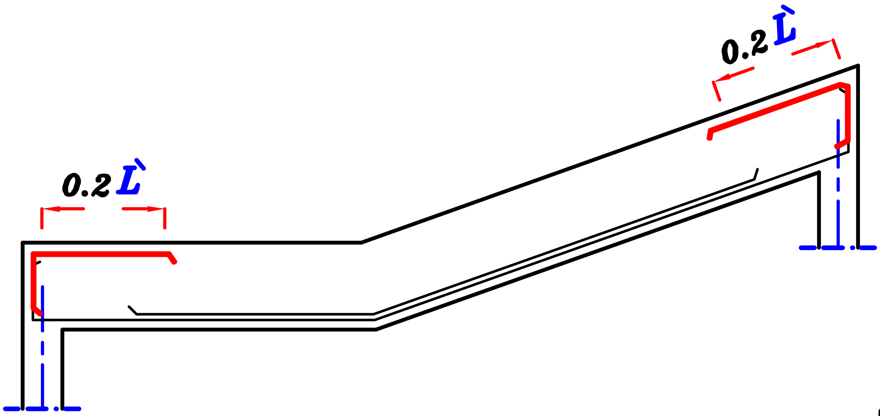
٦- باقى التسليح السفلى حتى مسافه *0.1 L`* من وش العمود الداخلى .
حيث *L`* هى الطول الحقيقى من *C.L.* الاعمده .

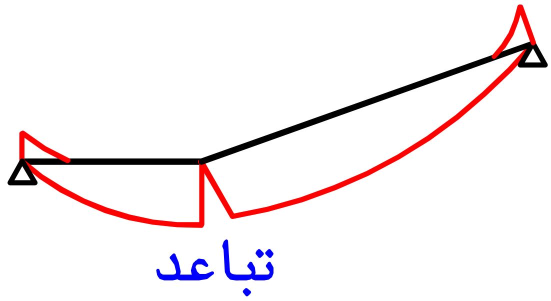


٧- يتم النظر عند الـ *joints* اذا وجد تباعد فى العزوم نكمل الحديد .
و اذا وجد تداخل فى العزوم يتم عمل مقص .

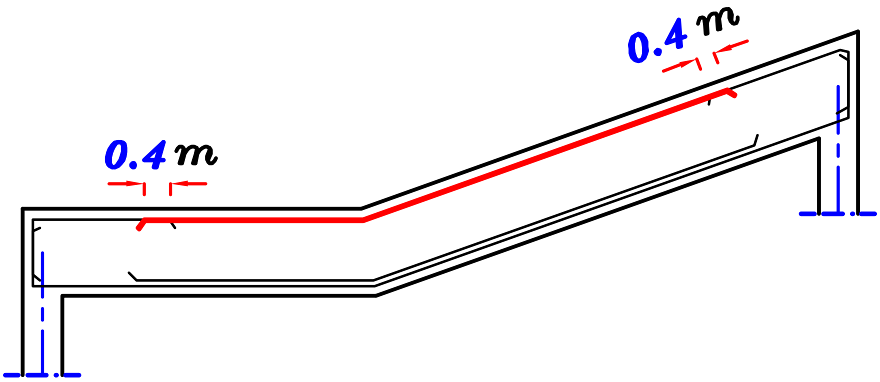


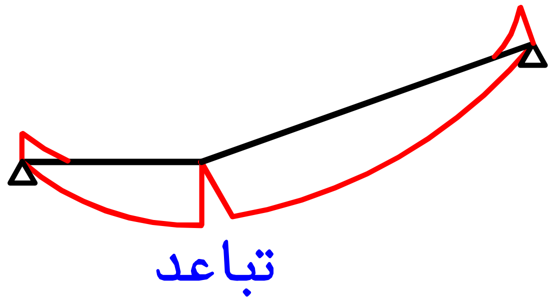
٨- نرسم التسليح الرئيسى للعزم $\frac{wLL'}{24}$ يعمل ركبه لاسفل عند نهايه الكمره
و من أعلى يمتد حتى مسافه $0.2\,L'$ من $C.L.$ العمود .



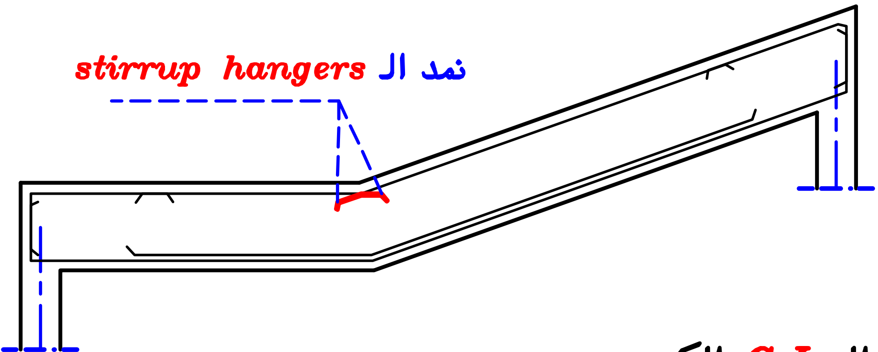


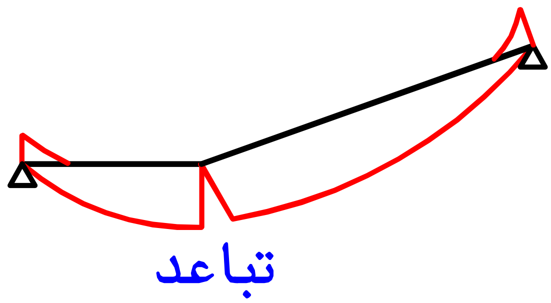
٩- فى المنطقه الباقيه نمد تسليح *stirrup Hangers*
و يعمل تداخل مع التسليح الرئيسى مسافه $0.4\ m$ على الطول المائل .



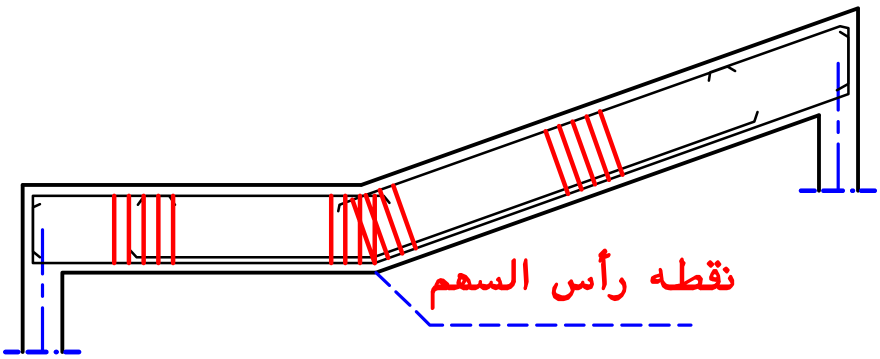


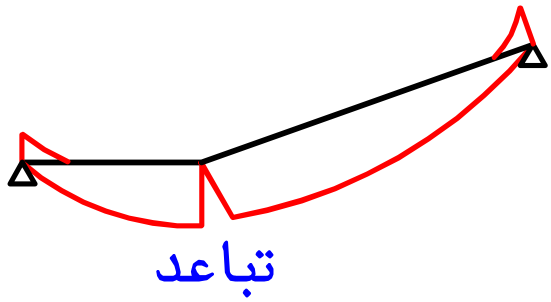
١٠- نمد تسليح ال *stirrup hangers* مسافه قليله حتى نعلق عليها الكانات





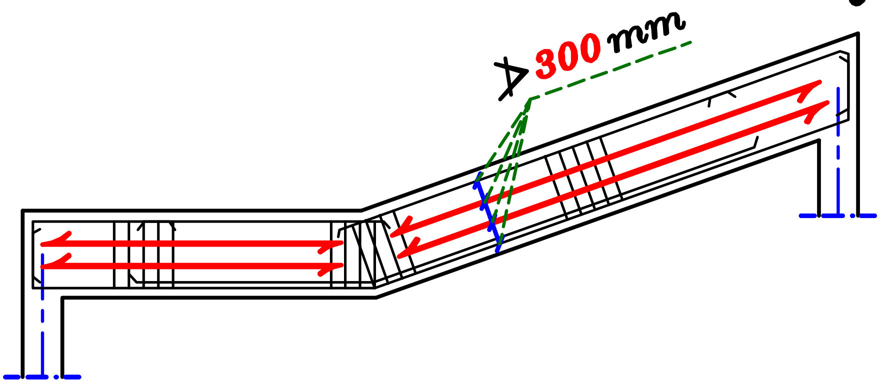
١١- نرسم الكانات عموديه على ال $C.L$ الكمره .
و عند التباعد نرسم الكانات من نقطه رأس السهم و عمودى على ال $C.L$

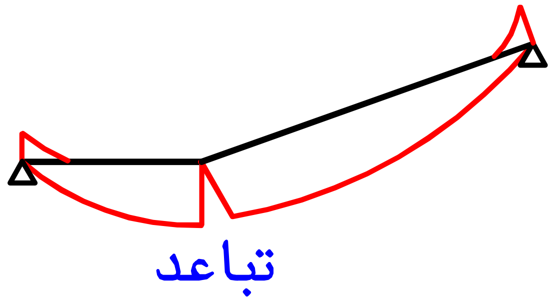




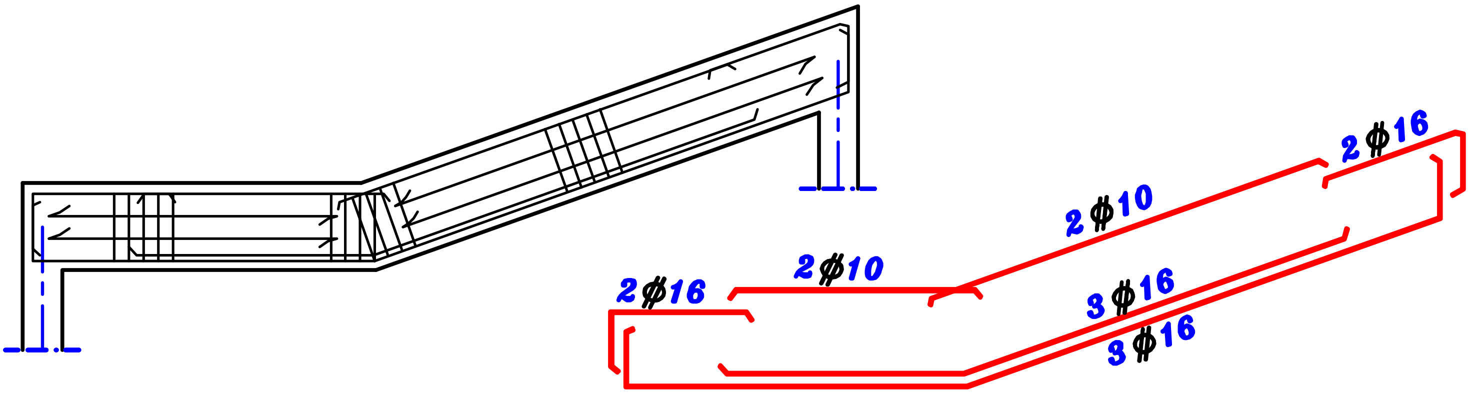
١٢- اذا كان عمق الكمره أكبر من *700 mm* نضع ***Shrinkage bars***

و تكون موازيه لـ ***C.L*** الكمره .

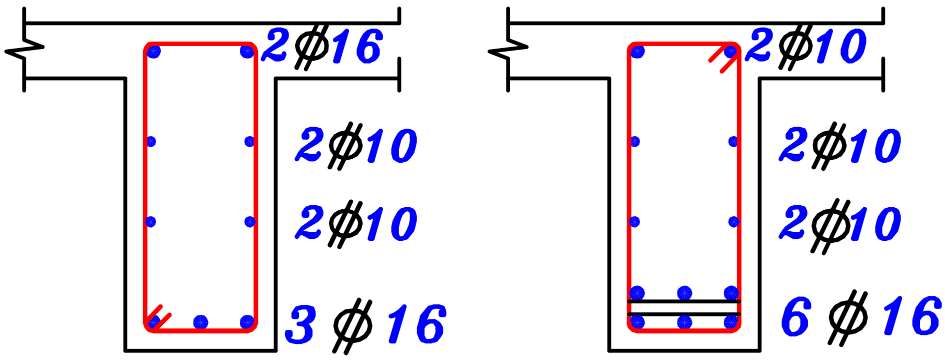


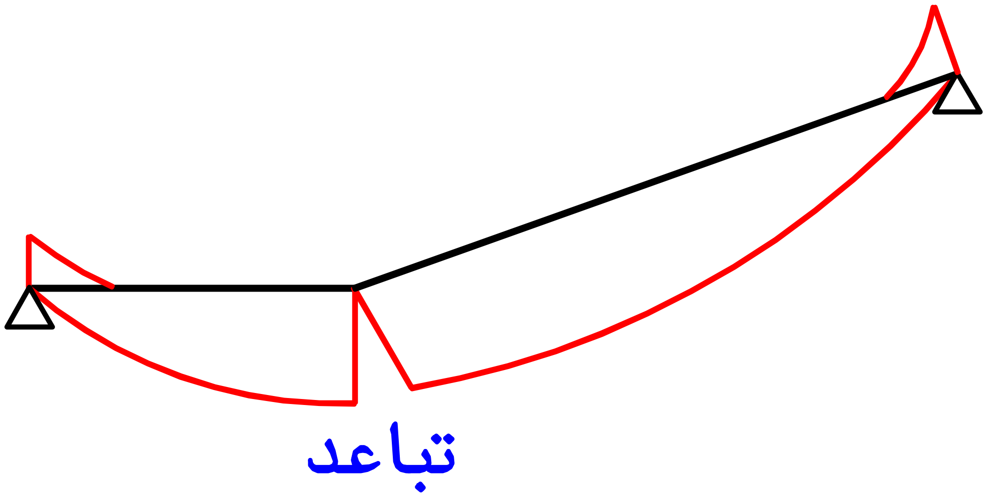


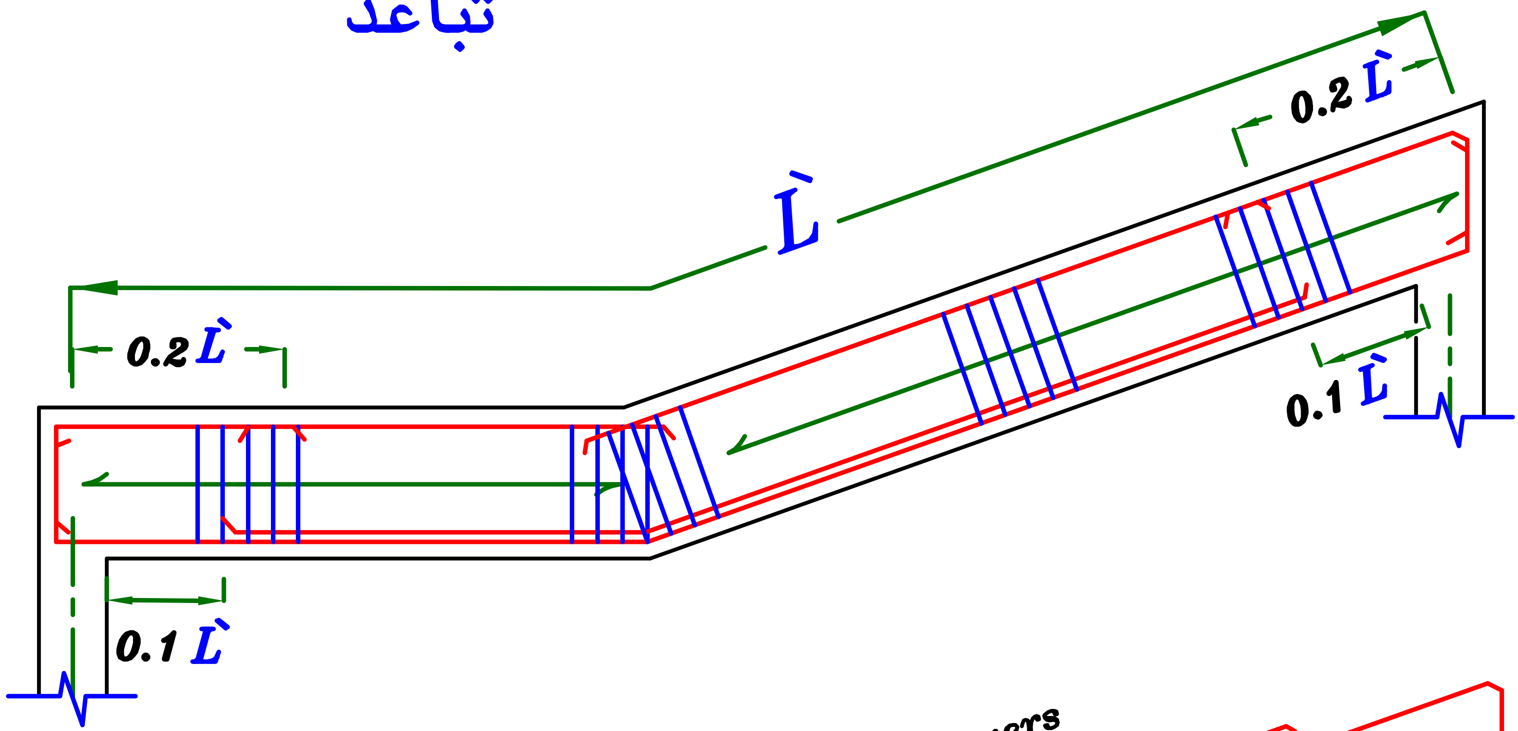
١٣- أسفل تسليح الكمره مباشره نرسم **التفريد** و يكون بنفس مقياس رسم الكمره

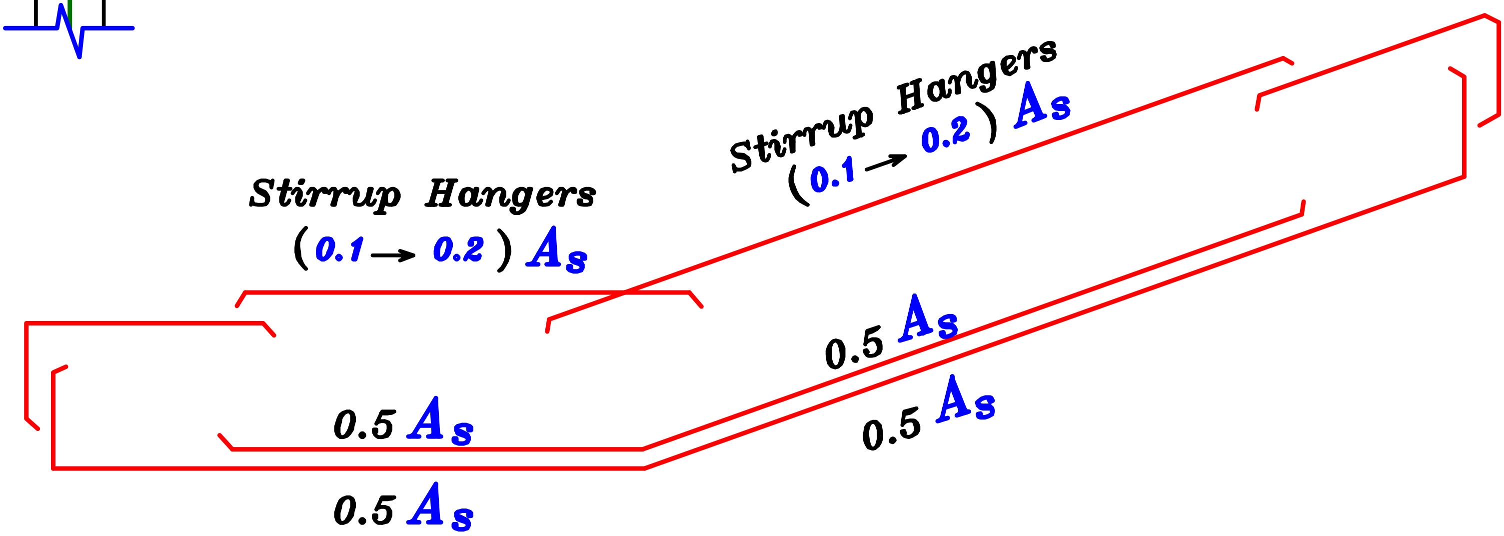


١٤- نرسم تسليح الكمره فى ***cross sections*** بمقياس رسم أكبر

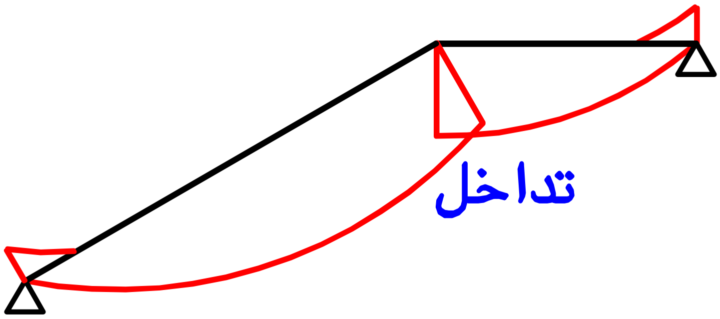



تباعد


L̀
0.2 L̀
0.2 L̀
0.1 L̀
0.1 L̀

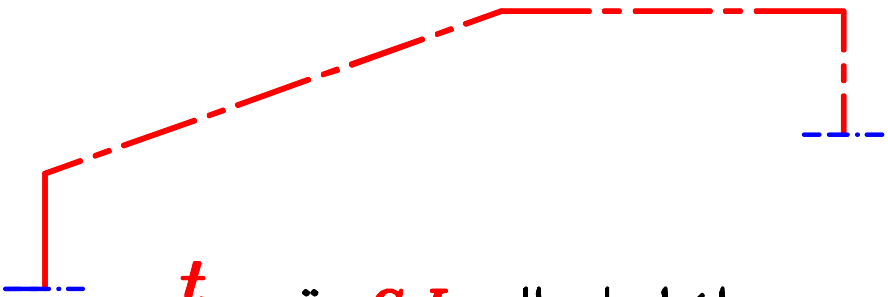

Stirrup Hangers
(0.1 → 0.2) As
Stirrup Hangers
(0.1 → 0.2) As
0.5 As
0.5 As
0.5 As
0.5 As

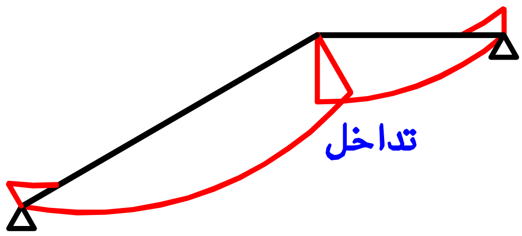
Example.



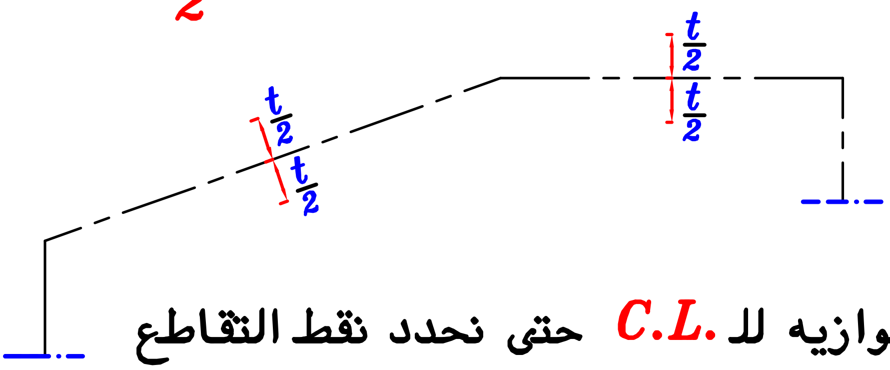
خطوات رسم تسليح الكمره فى ال *elevation*

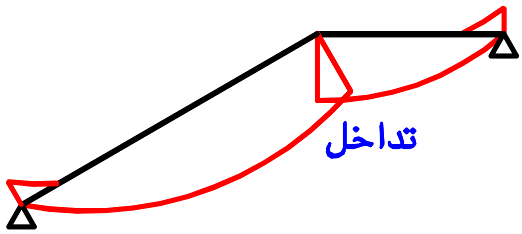
١ـ نرسم *C.L.* بمقياس الرسم المطلوب



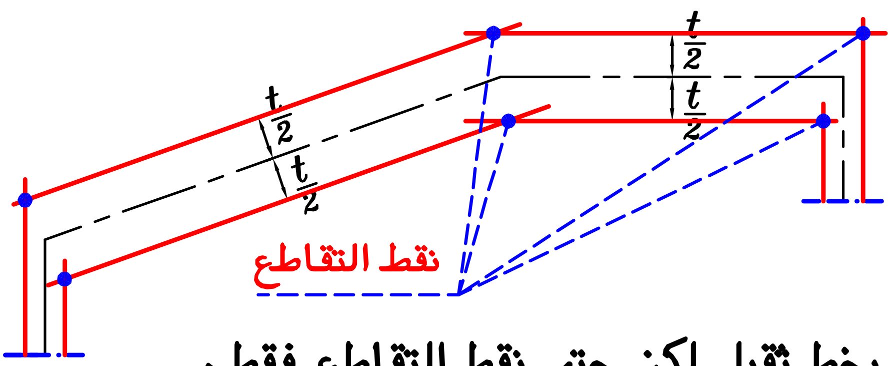


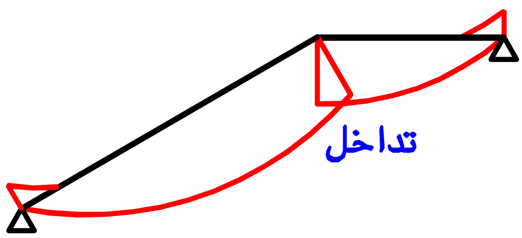
٢ـ نوقع التخانه للكمره عموديه دائما على ال *C.L.* بقيمه $\frac{t}{2}$



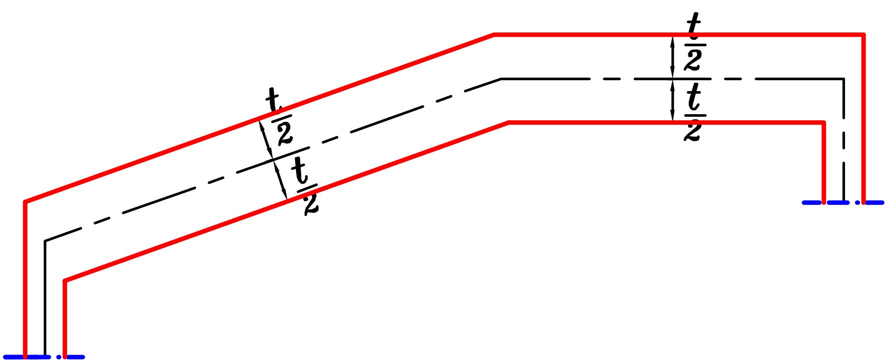


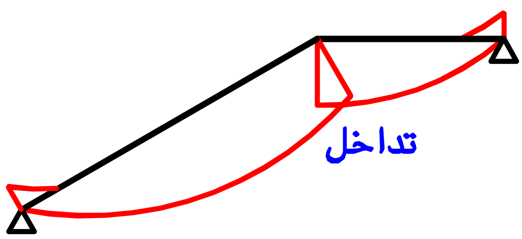
٣ـ نوصل خطوط خفيفه موازيه للـ *C.L.* حتى نحدد نقط التقاطع



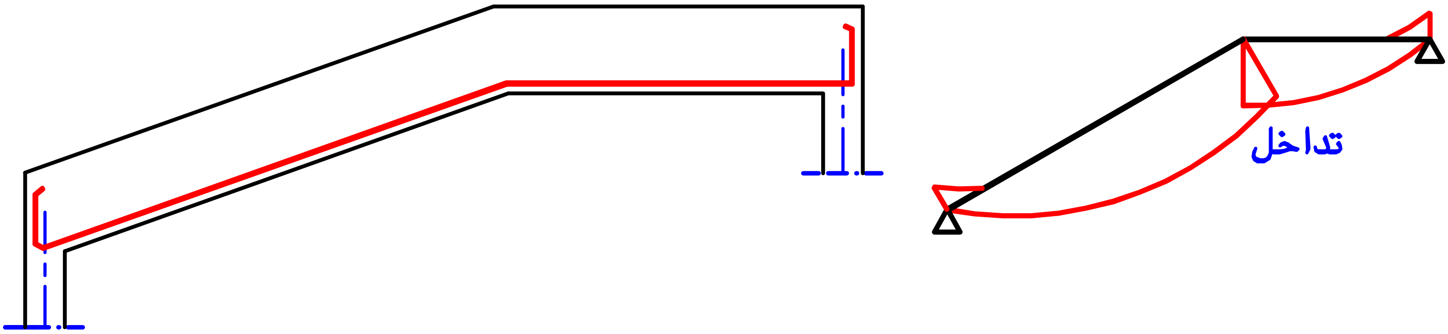


٤ـ نرسم الخطوط مره اخرى بخط تقيل لكن حتى نقط التقاطع فقط.

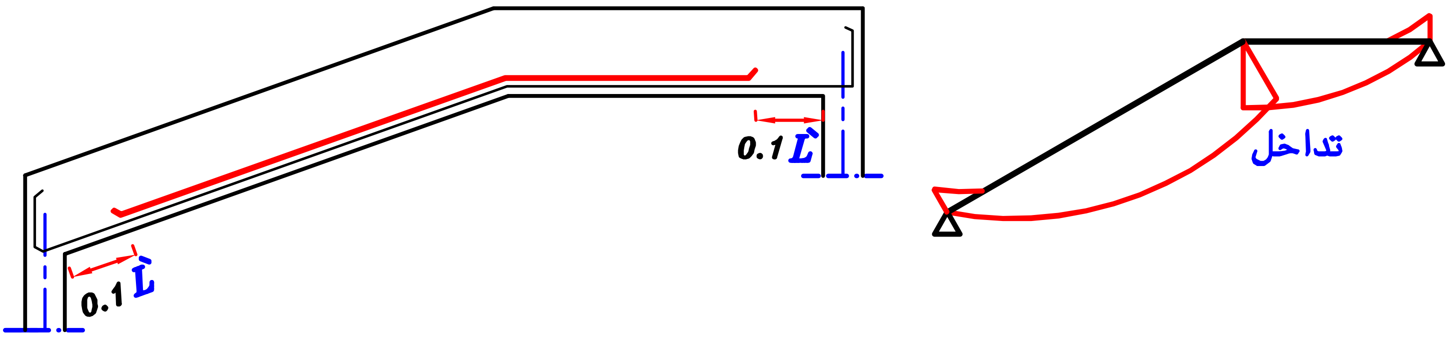




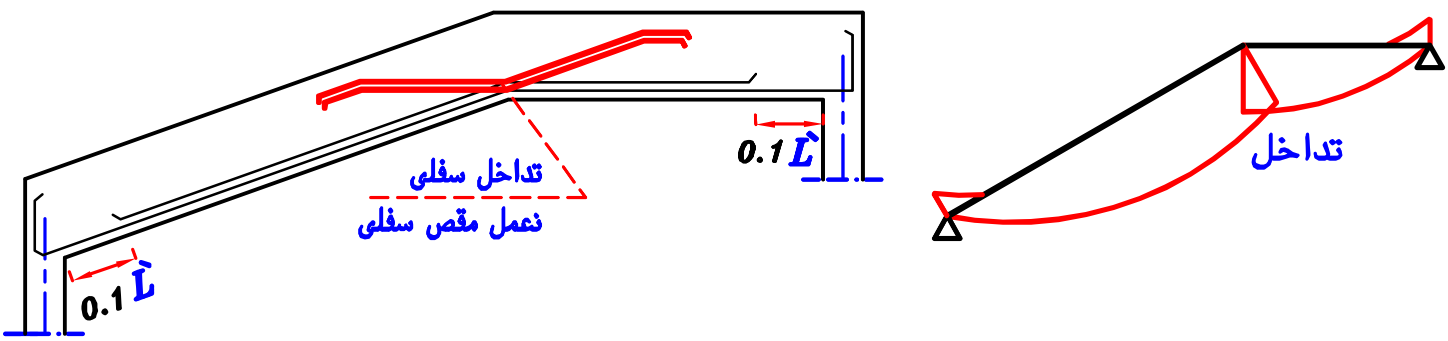
٥- نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود و نعمل له ركبه عند نهايه الكمره .



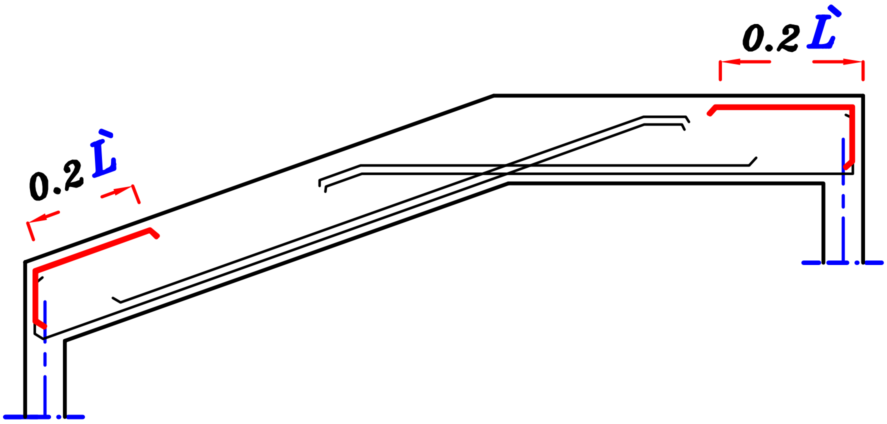
٦- باقى التسليح السفلى حتى مسافه $0.1\ L'$ من وش العمود الداخلى .
حيث L' هى الطول الحقيقى من $C.L.$ الاعمده .

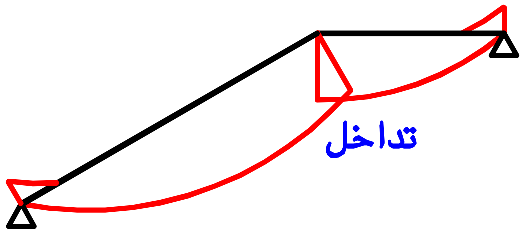


٧- يتم النظر عند ال joints اذا وجد تباعد فى العزوم نكمل الحديد .
و اذا وجد تداخل فى العزوم يتم عمل مقص .

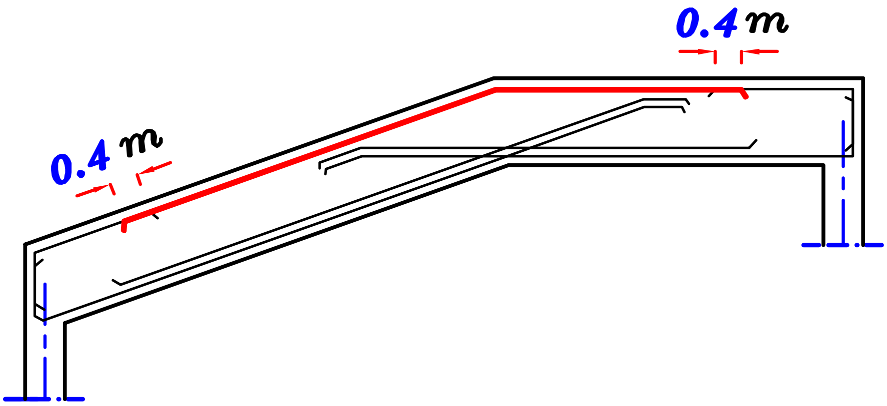


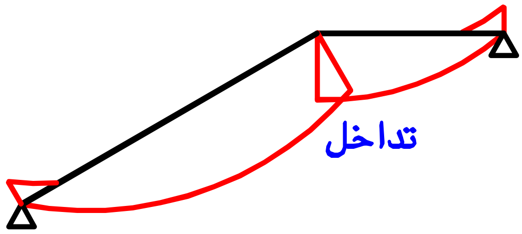
٨- نرسم التسليح الرئيسى للعزم $\frac{wLL`}{24}$ يعمل ركبه لاسفل عند نهايه الكمره
و من أعلى يمتد حتى مسافه $0.2\,L`$ من *C.L.* العمود .



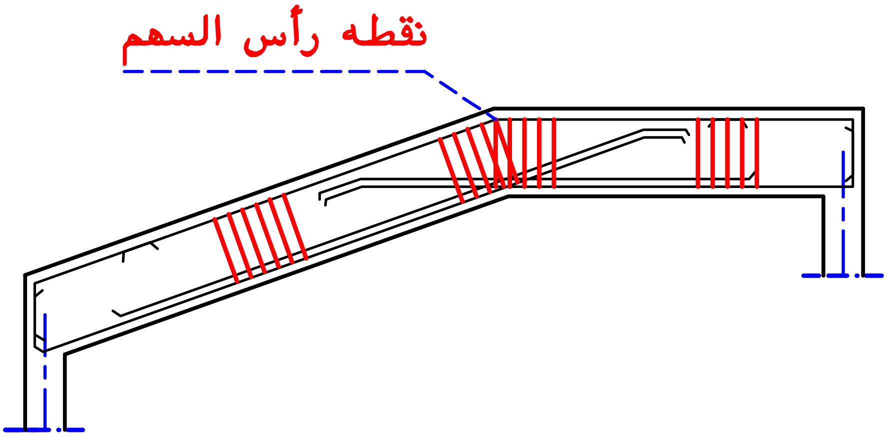


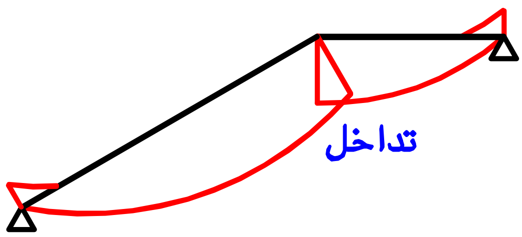
٩- فى المنطقه الباقيه نمد تسليح *stirrup Hangers*
و يعمل تداخل مع التسليح الرئيسى مسافه $0.4\,m$ على الطول المائل .



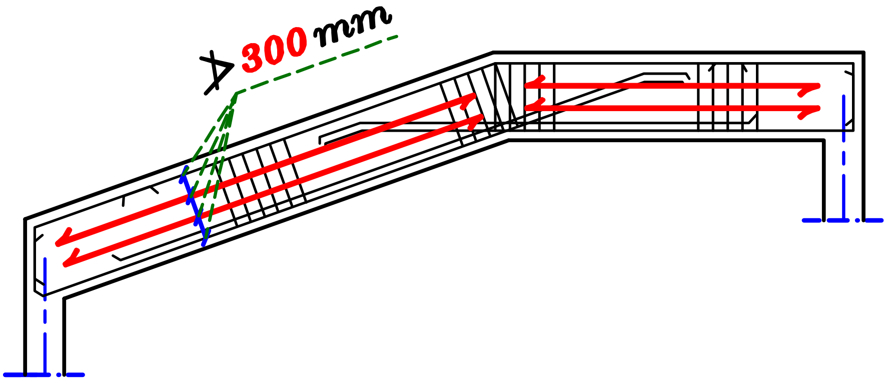


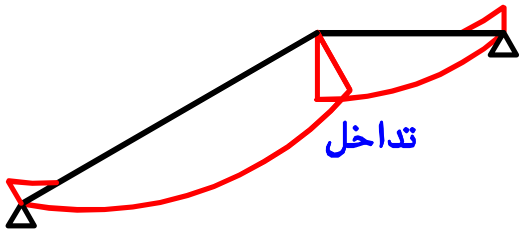
١٠ - نرسم الكانات عموديه على الـ *C.L* الكمره .
و عند التباعد نرسم الكانات من نقطه رأس السهم و عمودى على الـ *C.L*



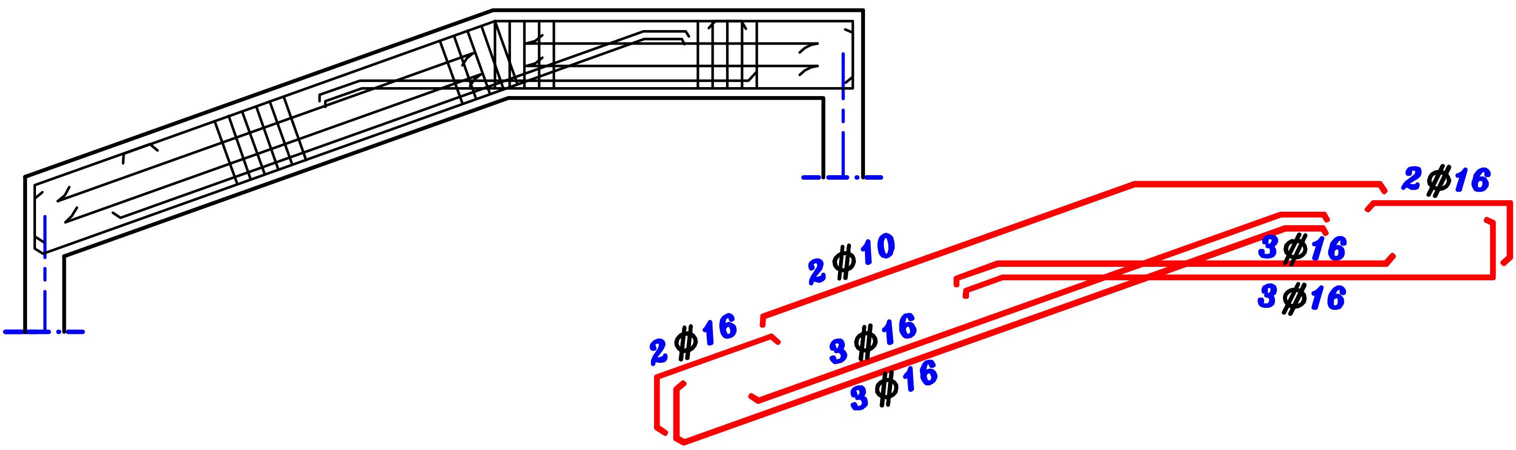


١١- اذا كان عمق الكمره أكبر من *700 mm* نضع *Shrinkage bars* و تكون موازيه لـ *C.L* الكمره .

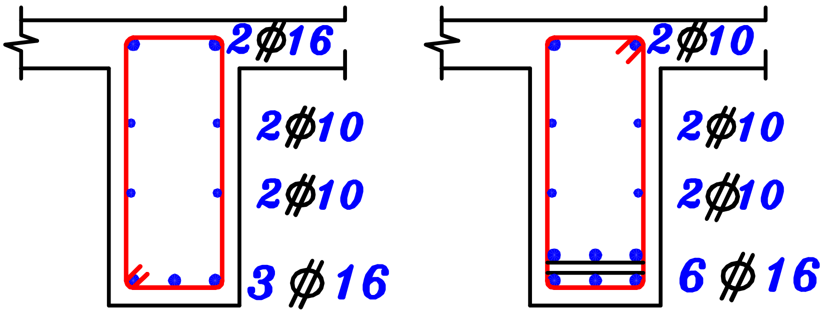


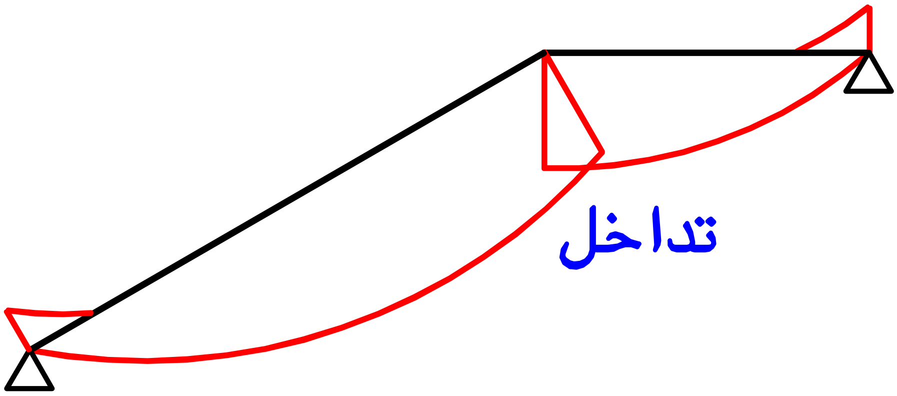


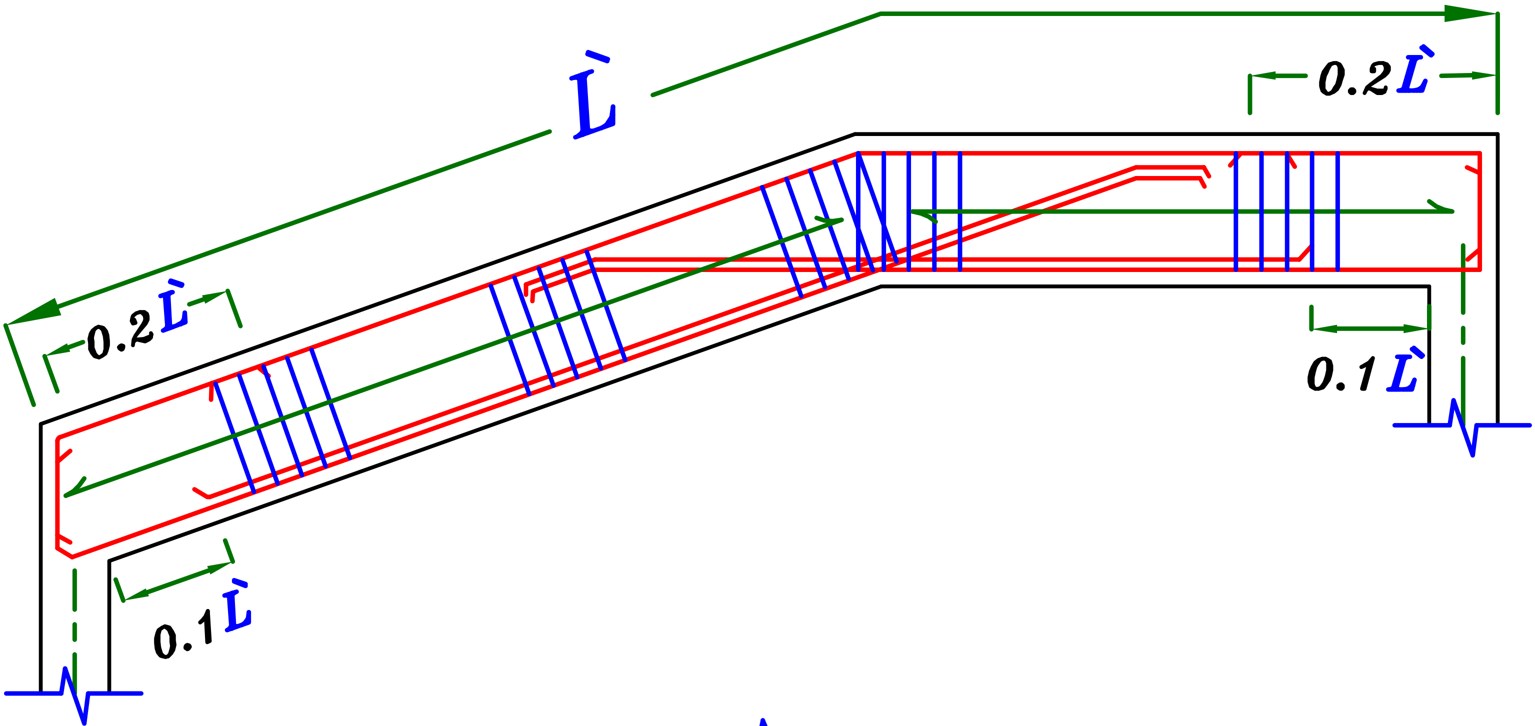
١٢- أسفل تسليح الكمره مباشره نرسم **التفريد** و يكون بنفس مقياس رسم الكمره

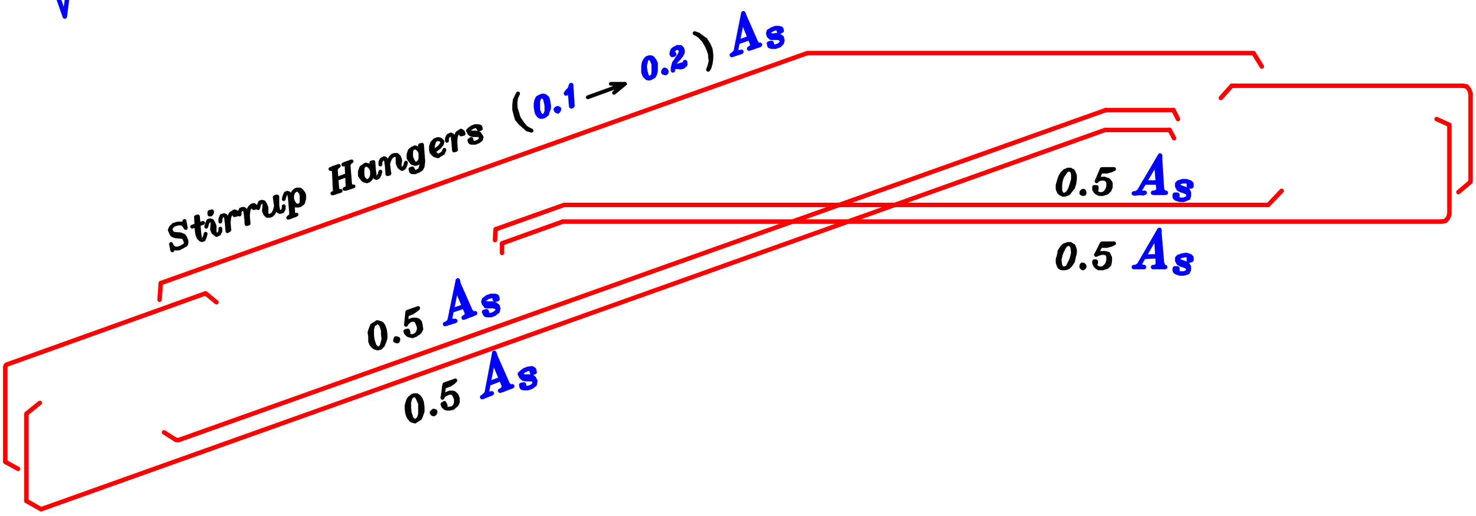


١٣- نرسم تسليح الكمره فى *cross sections* بمقياس رسم أكبر

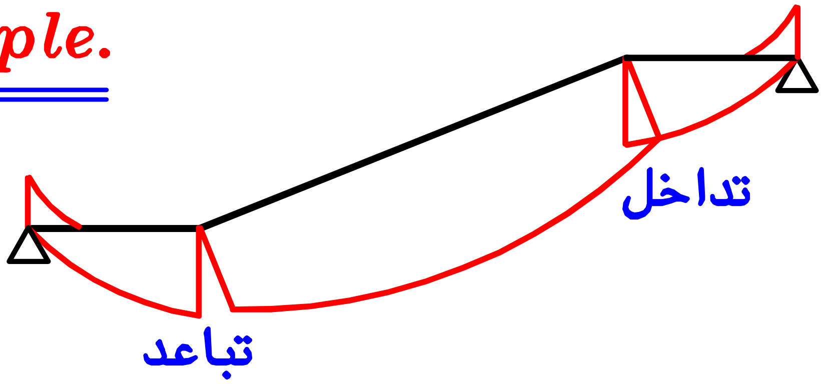



تداخل


L̀
0.2 L̀
0.2 L̀
0.1 L̀
0.1 L̀

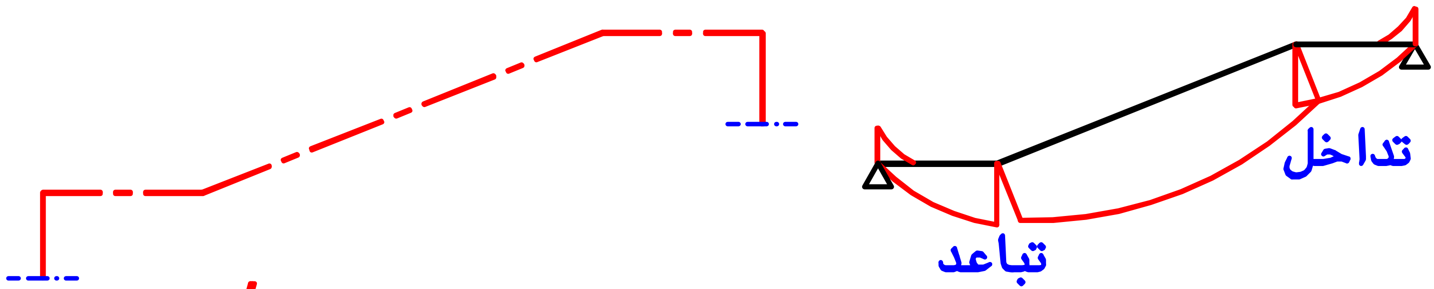

Stirrup Hangers (0.1 → 0.2) As
0.5 As
0.5 As
0.5 As
0.5 As

Example.

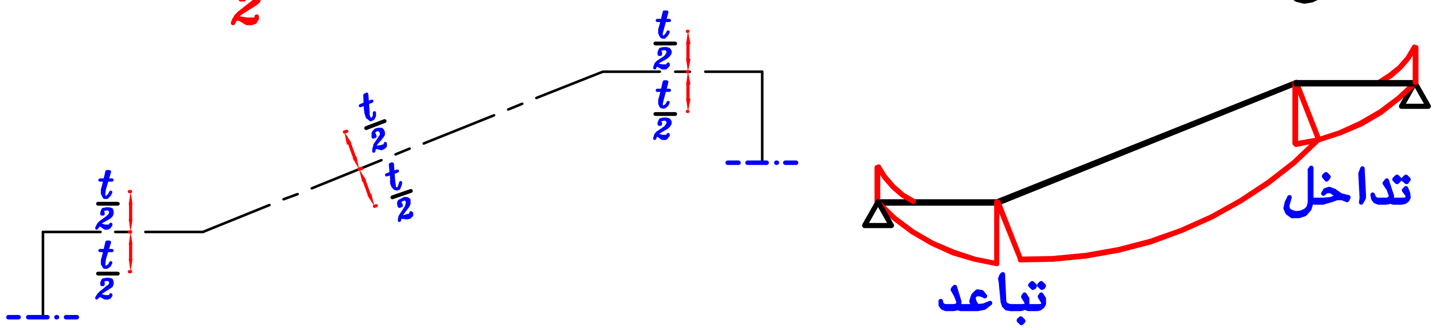


خطوات رسم تسليح الكمره فى ال elevation

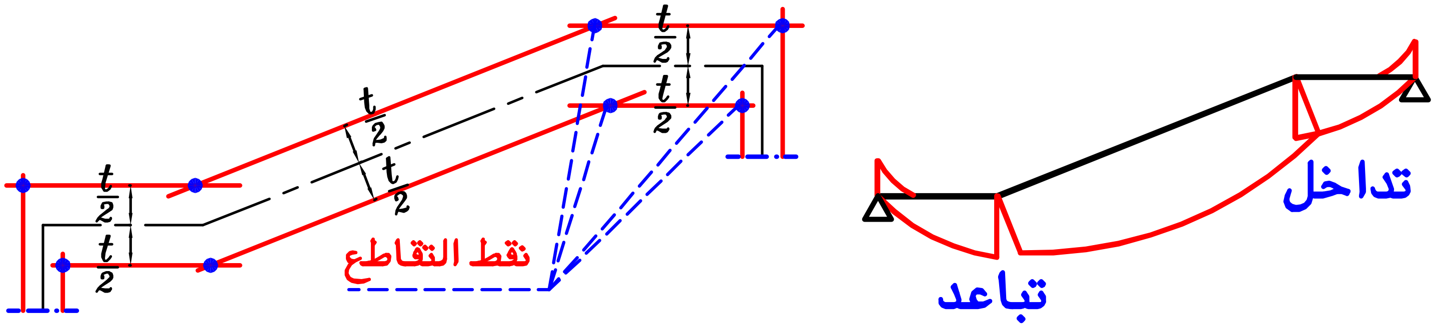
١- نرسم C.L. بمقياس الرسم المطلوب



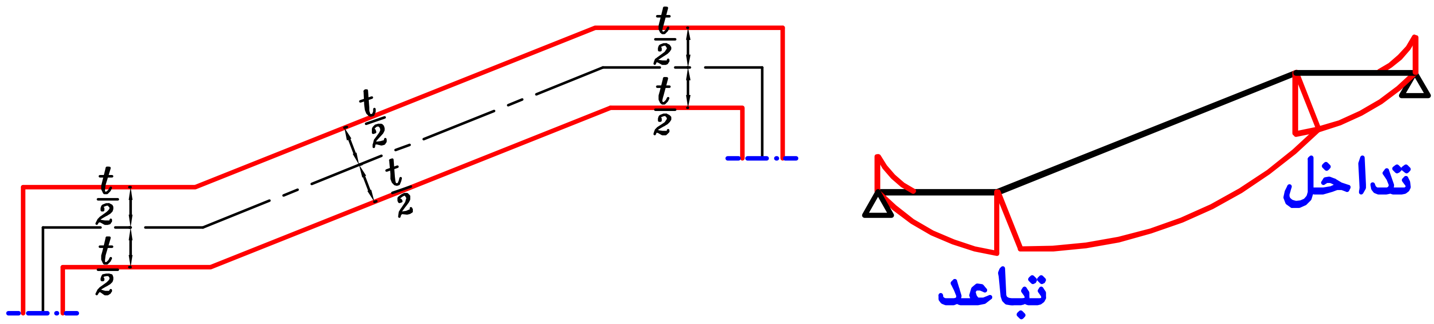
٢- نوقع التخانه للكمره عموديه دائما على ال C.L. بقيمه $\frac{t}{2}$



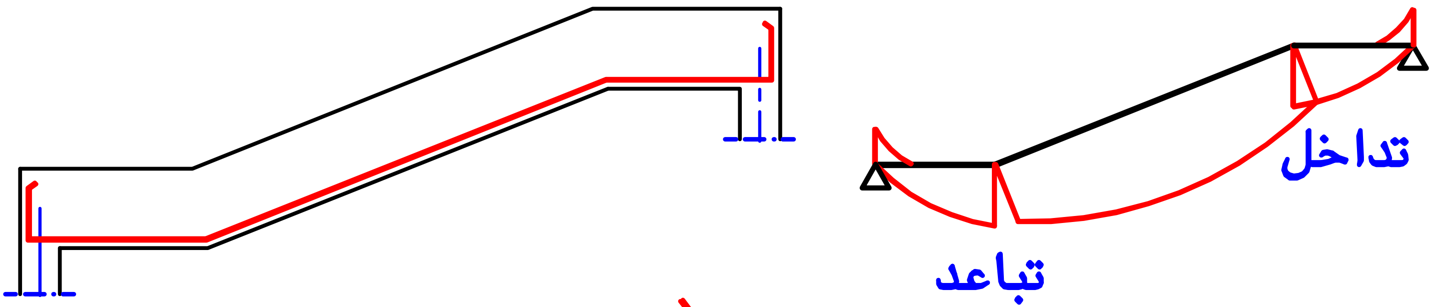
٣- نوصل خطوط خفيفه موازيه لل C.L. حتى نحدد نقط التقاطع



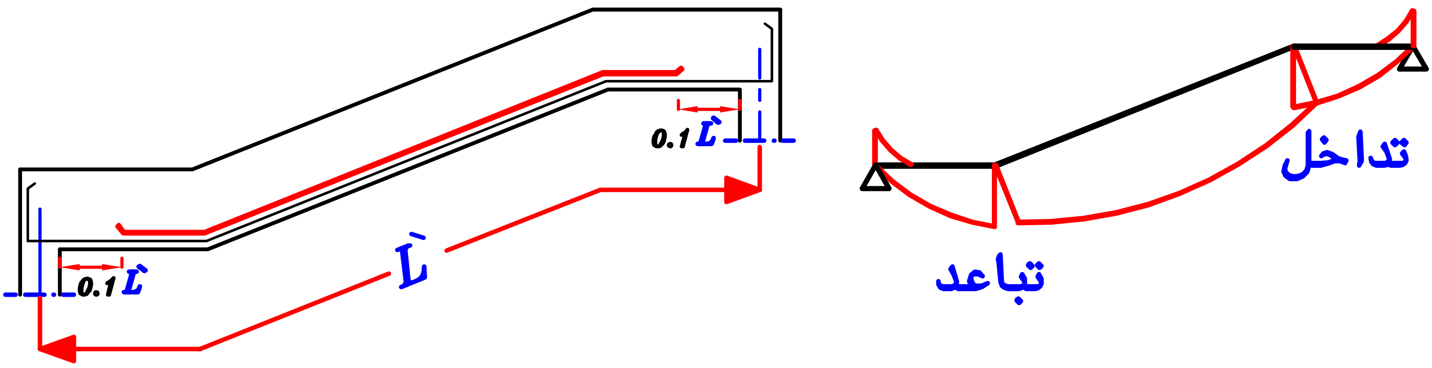
٤- نرسم الخطوط مره اخرى بخط ثقيل لكن حتى نقط التقاطع فقط.



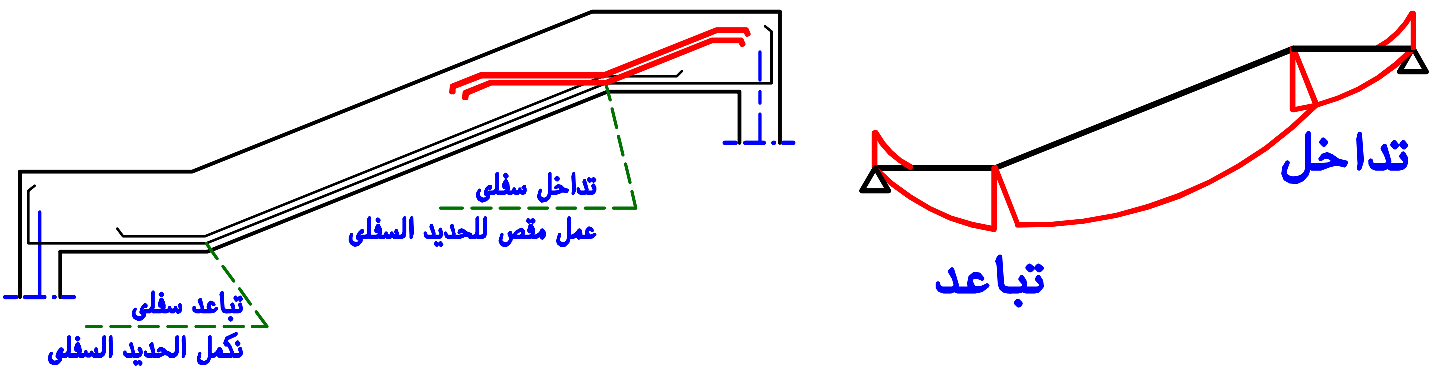
٥- نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود
و نعمل له ركبه عند نهايه الكمره .



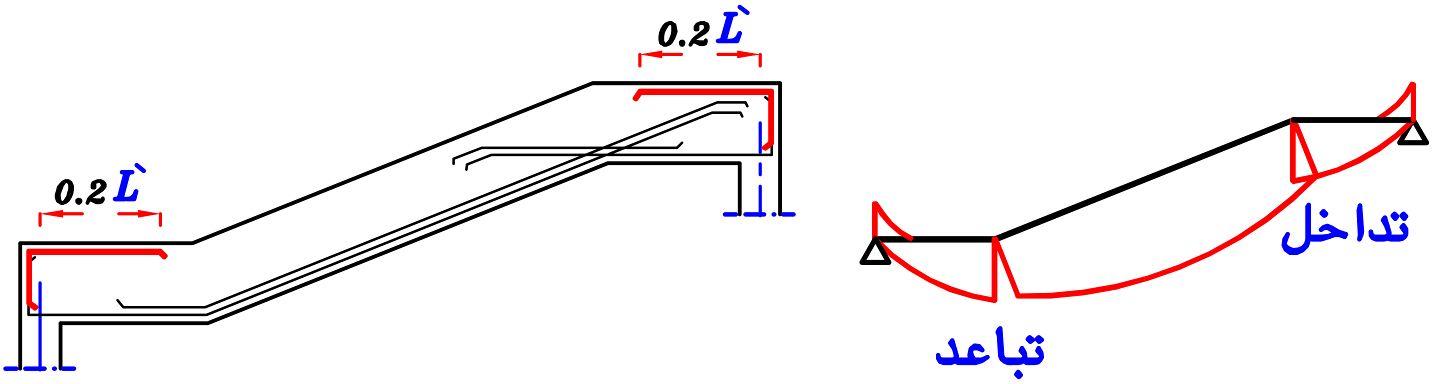
٦- باقى التسليح السفلى حتى مسافه $0.1\ L`$ من وش العمود الداخلى .
حيث $L`$ هى الطول الحقيقى من $C.L.$ الاعمده .



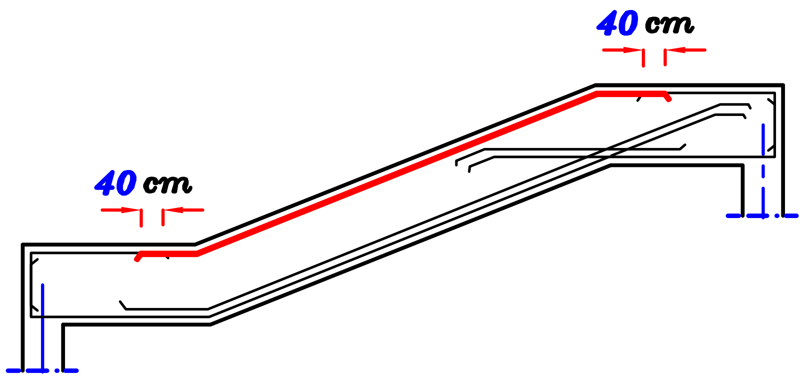
٧- يتم النظر عند ال *joints* اذا وجد تباعد فى العزوم نكمل الحديد .
و اذا وجد تداخل فى العزوم يتم عمل مقص .

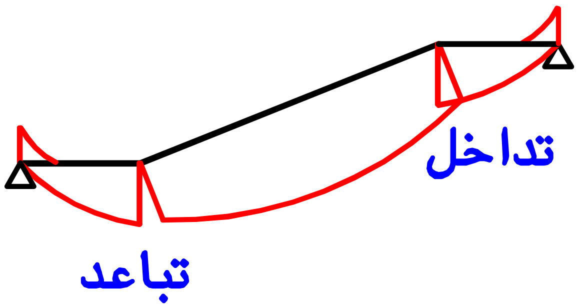


٨- نرسم التسليح الرئيسى للعزم $\frac{wLL`}{24}$ يعمل ركبه لاسفل عند نهايه الكمره
و من أعلى يمتد حتى مسافه $0.2\ L`$ من $C.L.$ العمود .

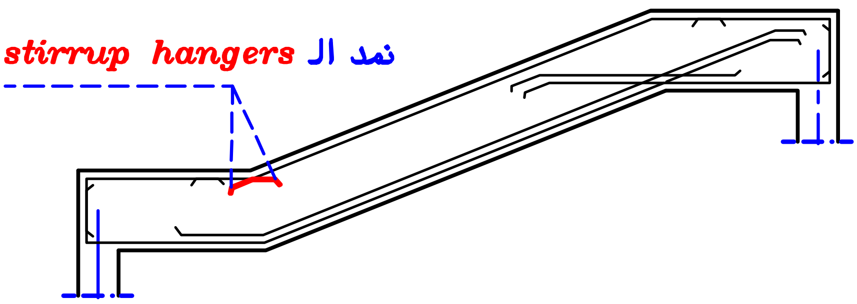


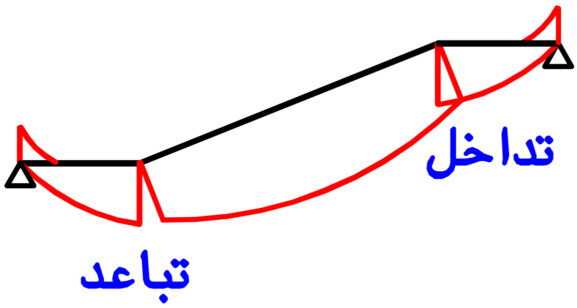
٩- فى المنطقه الباقيه نمد تسليح ***stirrup Hangers***
و يعمل تداخل مع التسليح الرئيسى مسافه ***0.4 m*** على الطول المائل .



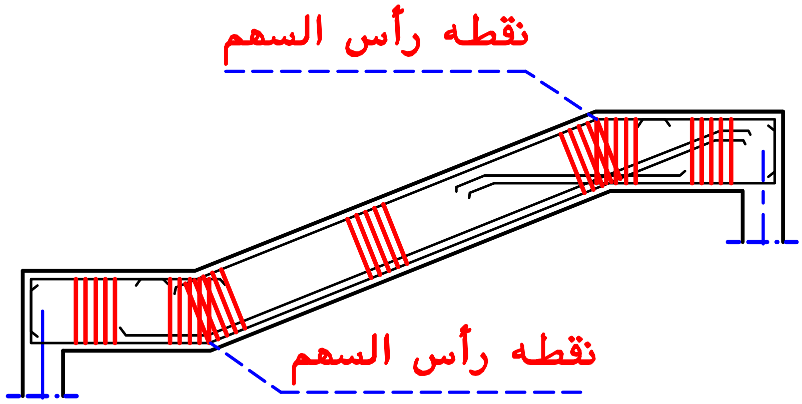


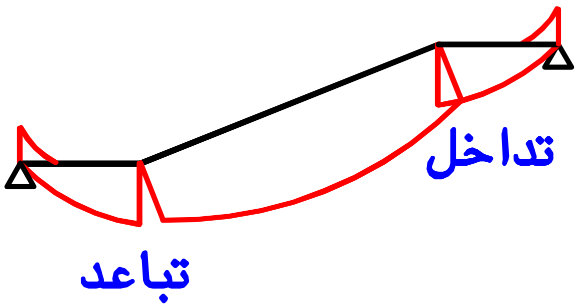
١٠- نمد تسليح الـ ***stirrup hangers*** مسافه قليله حتى نعلق عليها الكانات



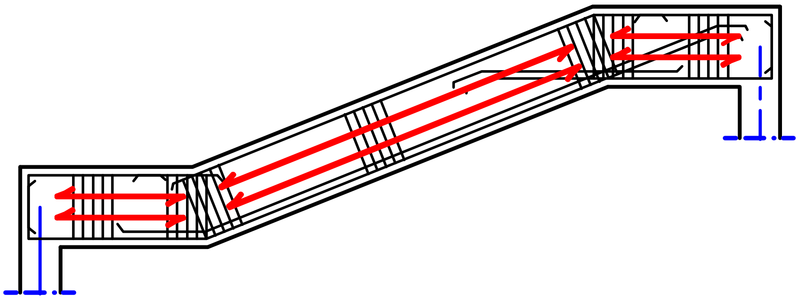


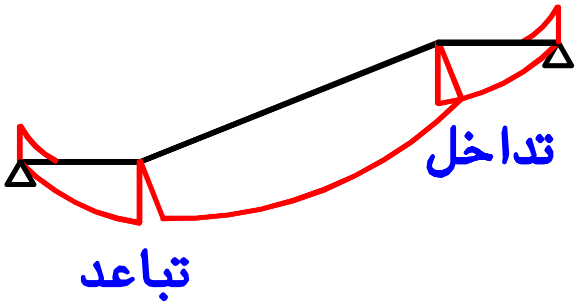
١١- نرسم الكانات عموديه على الـ ***C.L*** الكمره .
و عند التباعد نرسم الكانات من نقطه رأس السهم و عمودى على الـ ***C.L***



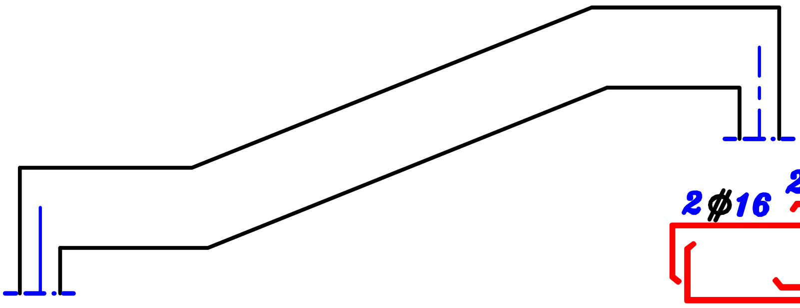


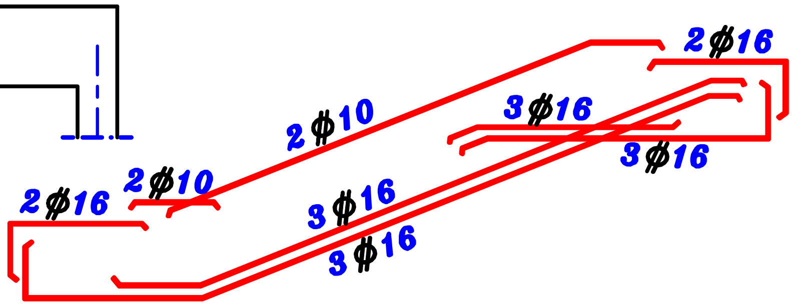
١٢- اذا كان عمق الكمره أكبر من *700 mm* نضع *Shrinkage bars* و تكون موازيه لـ *C.L* الكمره .



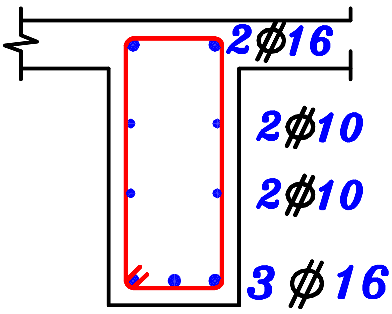


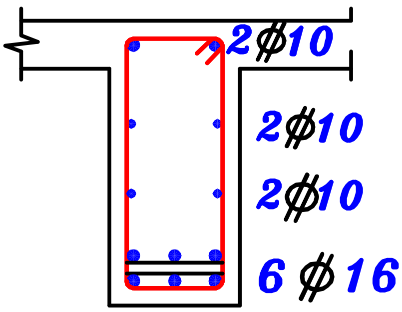
١٣- أسفل تسليح الكمره مباشره نرسم **التفريد** و يكون بنفس مقياس رسم الكمره

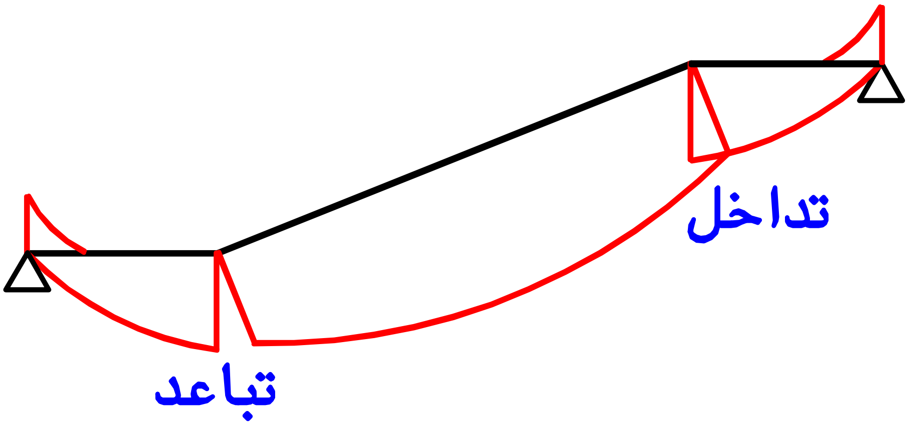


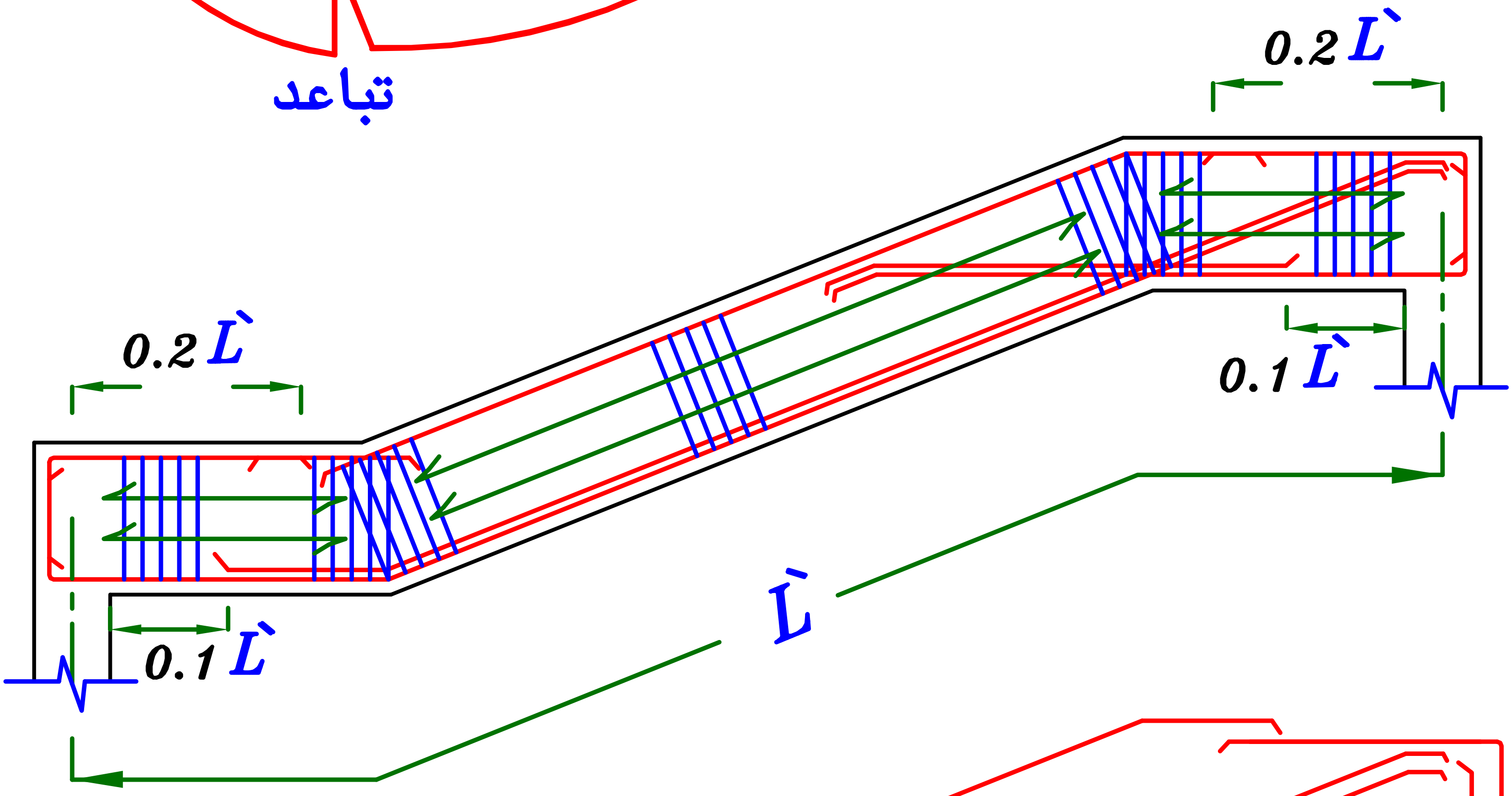


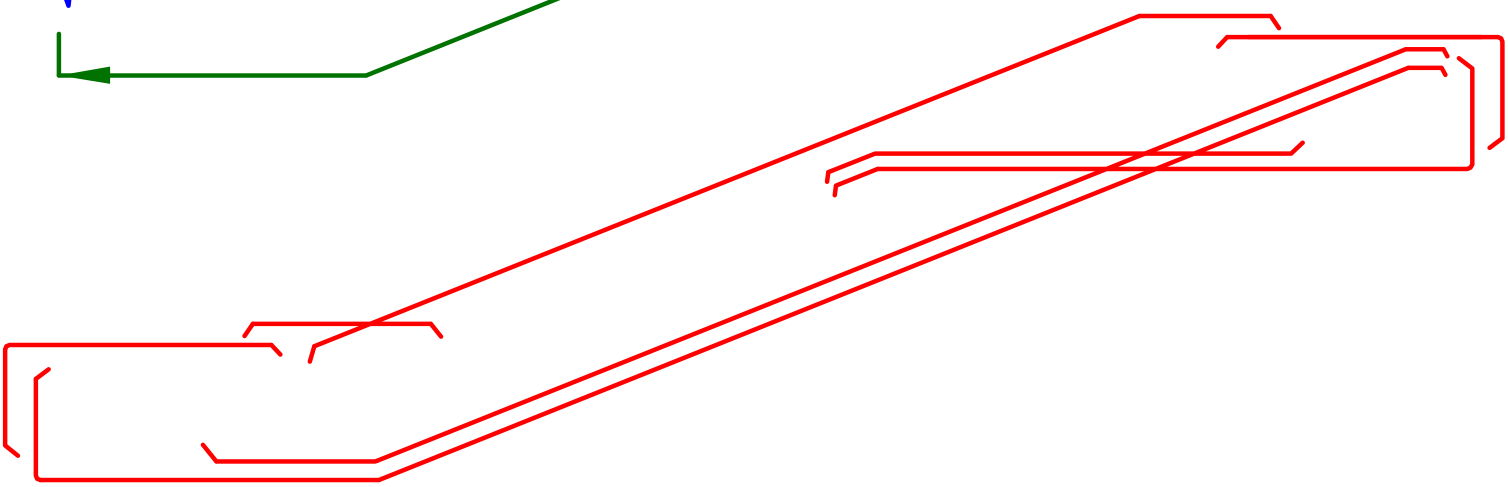
١٤- نرسم تسليح الكمره فى *cross sections* بمقياس رسم أكبر



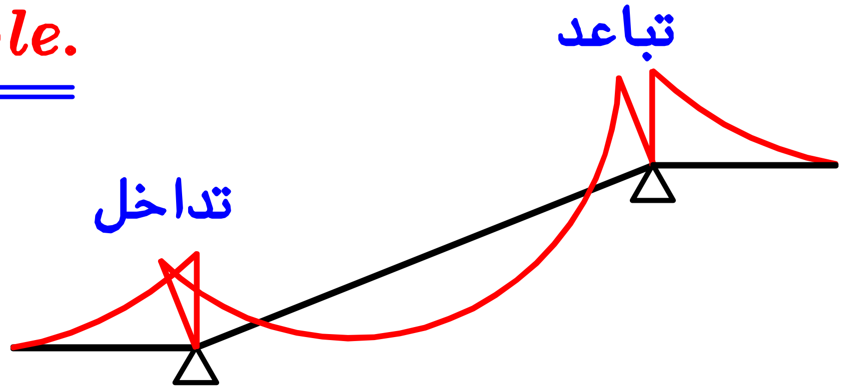



تداخل
تباعد


0.2 L`
0.2 L`
0.1 L`
0.1 L`
L`

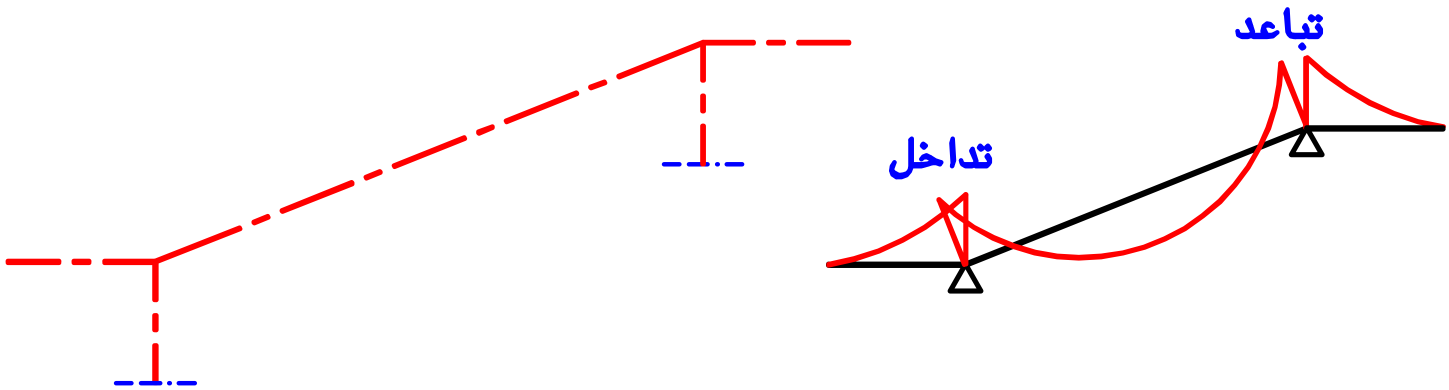


Example.

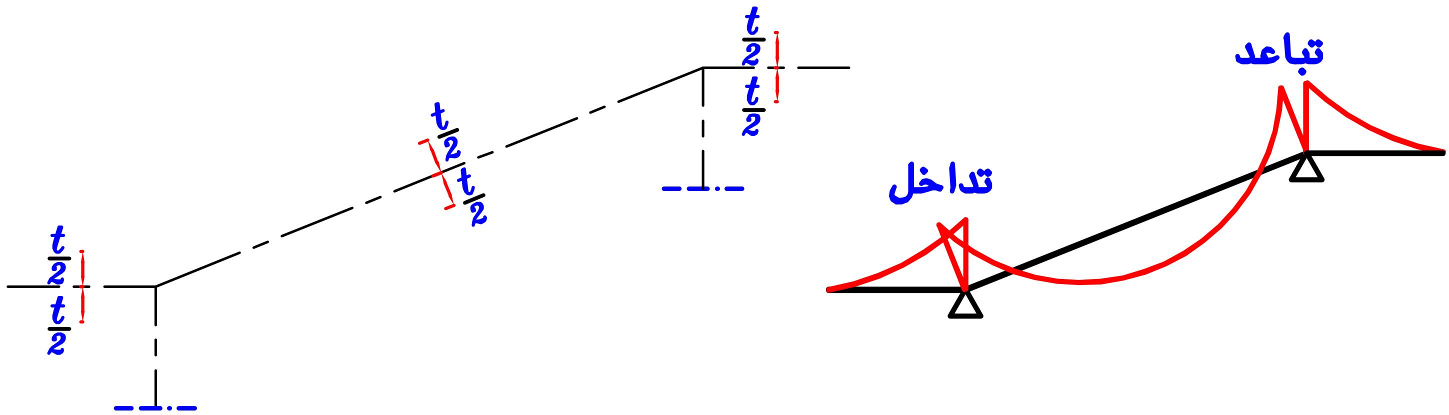


خطوات رسم تسليح الكمره فى ال *elevation*

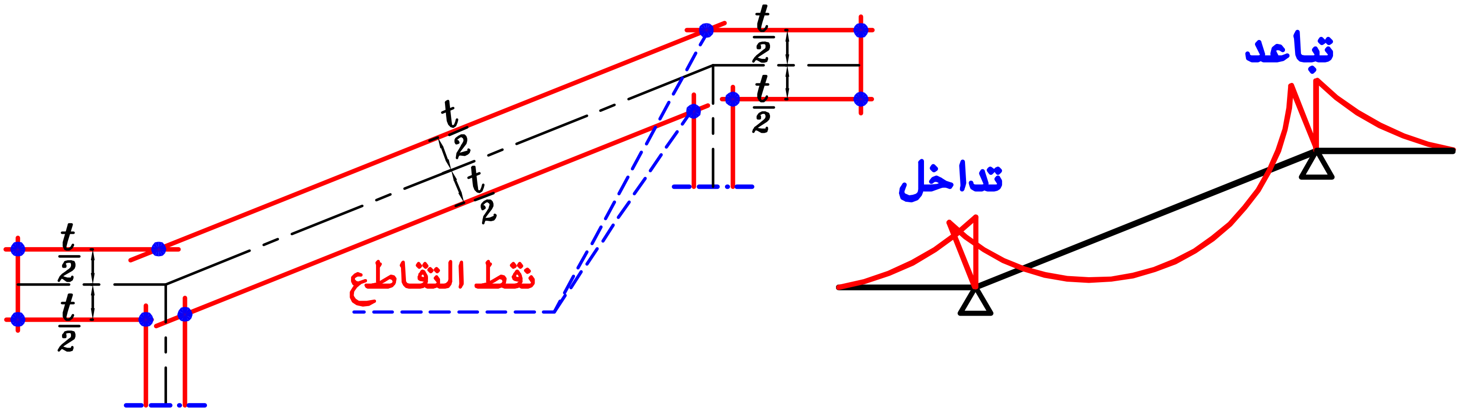
١- نرسم *C.L.* بمقياس الرسم المطلوب



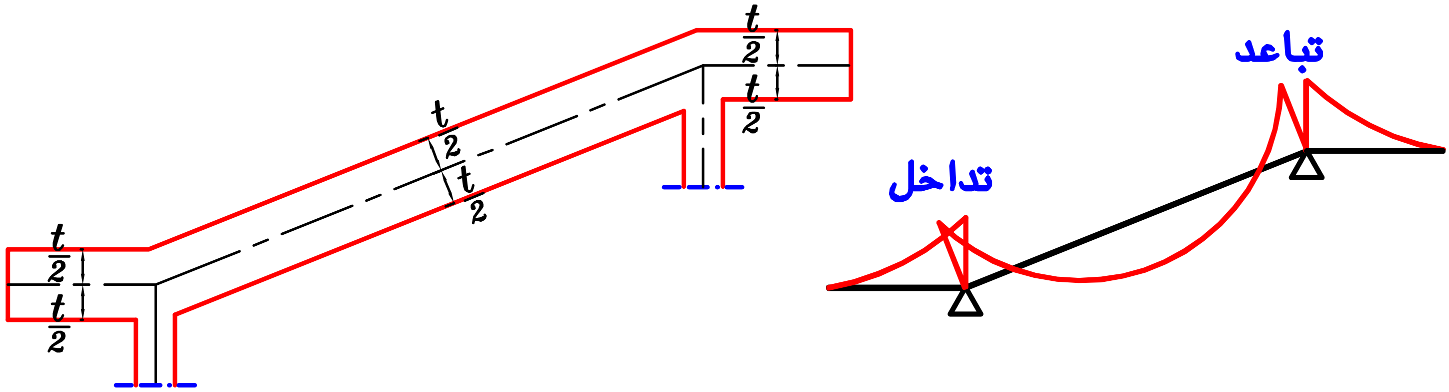
٢- نوقع التخانه للكمره عموديه دائما على ال *C.L.* بقيمه $\frac{t}{2}$



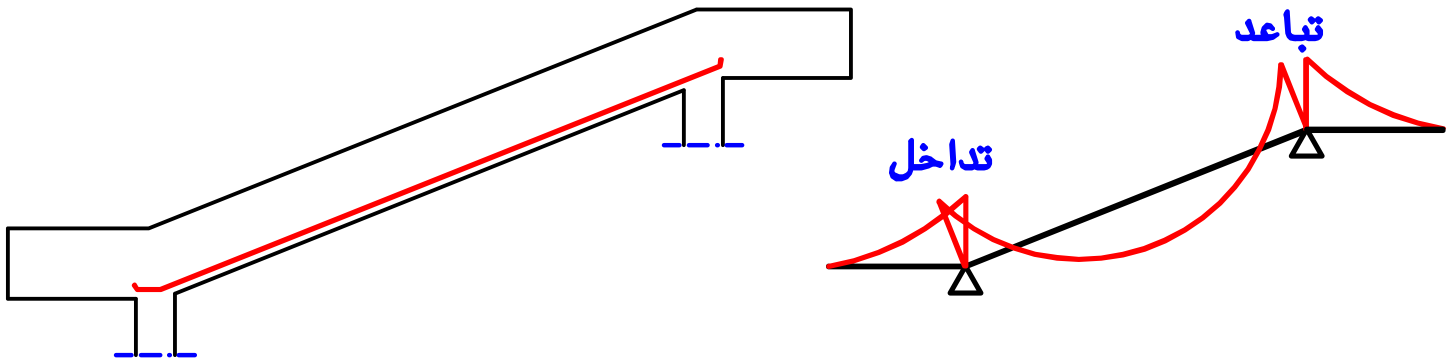
٣- نوصل خطوط خفيفه موازيه لل *C.L.* حتى نحدد نقط التقاطع



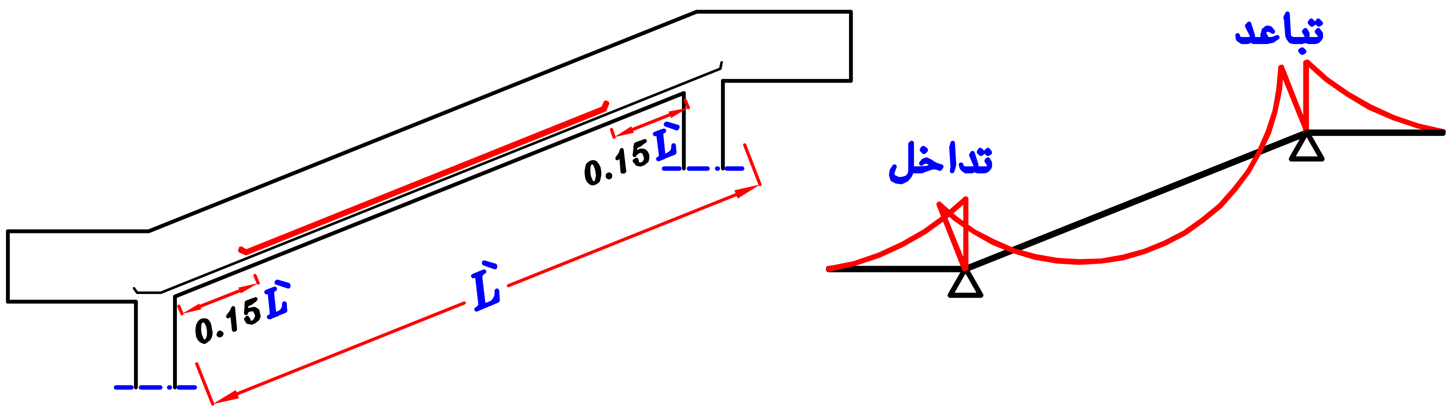
٤ـ نرسم الخطوط مره اخرى بخط ثقيل لكن حتى نقط التقاطع فقط.



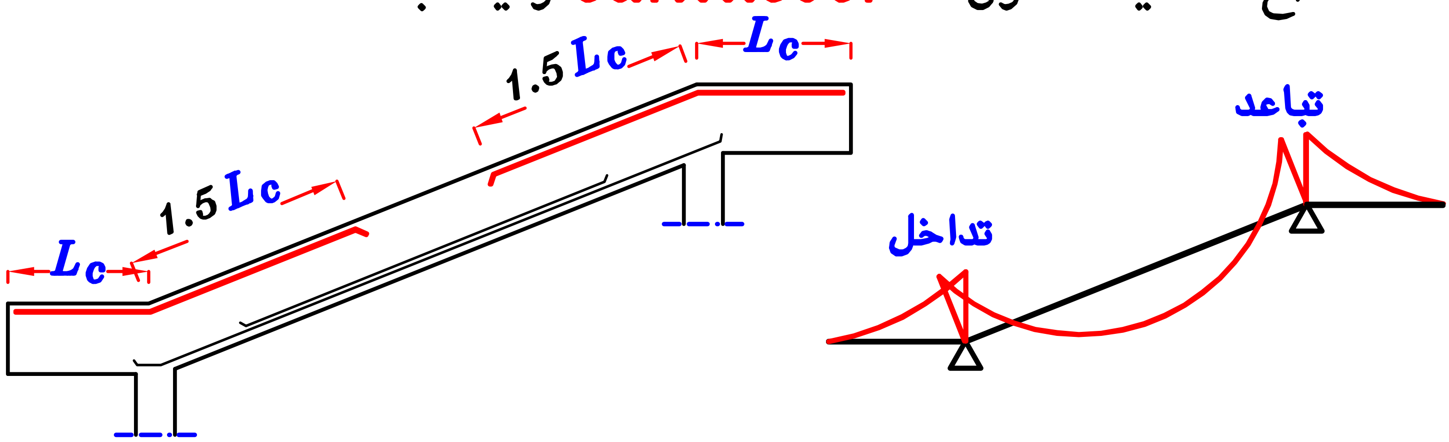
٥ـ نرسم نصف التسليح السفلى (أو أكثر) من وش العمود الى وش العمود



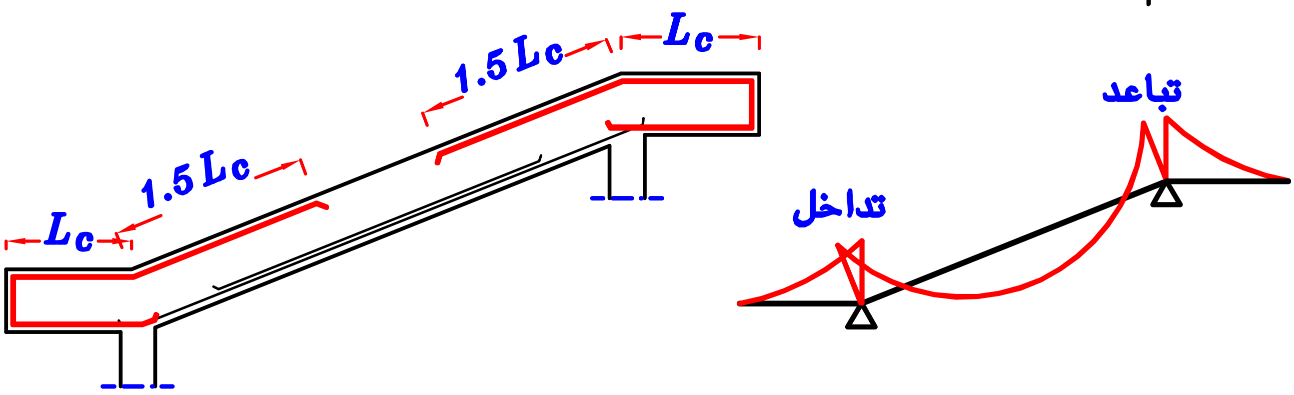
٦ـ باقى التسليح السفلى حتى مسافه $0.15L`$ من وش العمود الداخلى.
حيث $L`$ هى الطول الحقيقى من C.L. الاعمده.



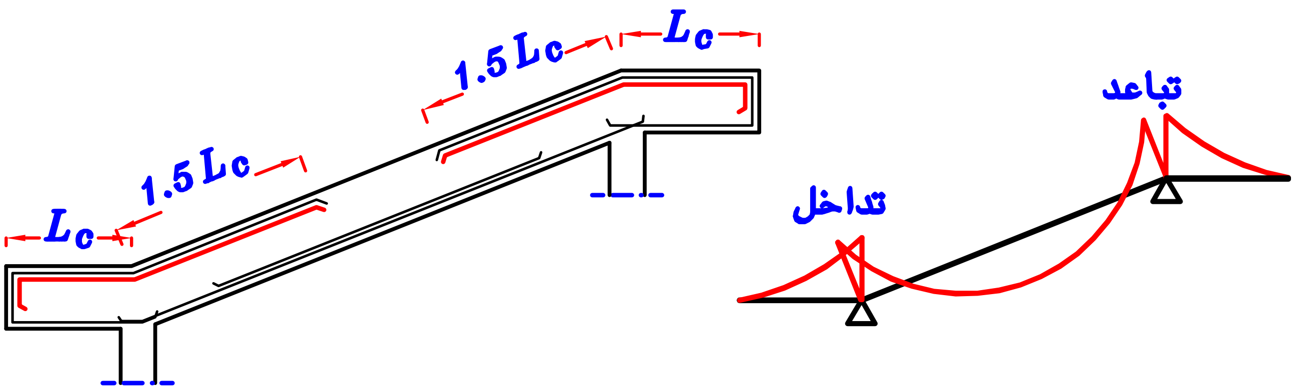
٧- نضع الحديد العلوى للـ cantilever و يمد بعدها مسافه $1.50\,L_c$



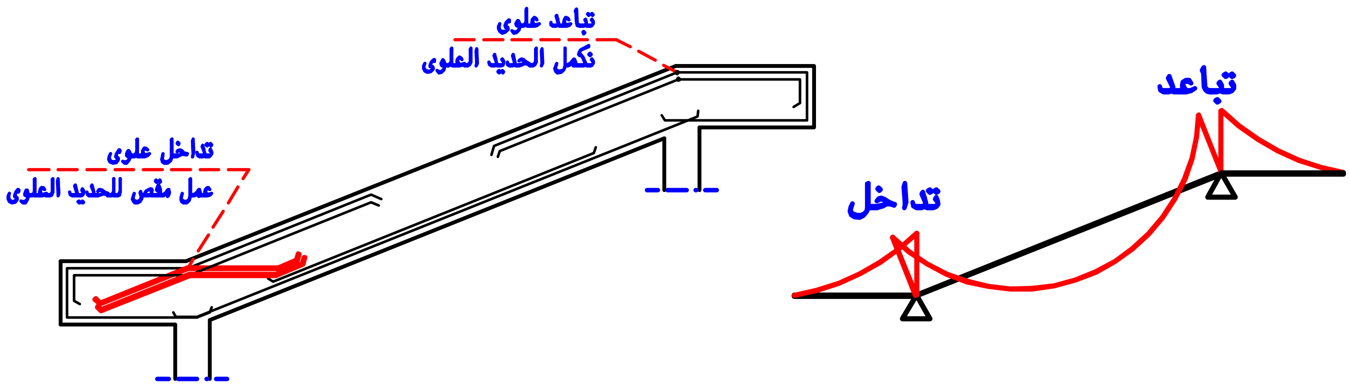
٧- يتم عمل شوكه حتى وش العمود للـ cantilever



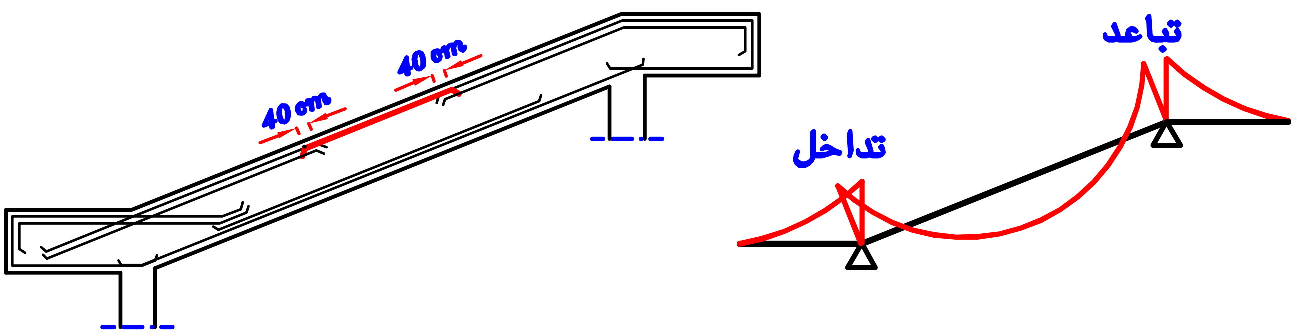
٨- ممكن اخذ نصف تسليح الـ cantilever بحيث يمتد مسافه $1.5\ L_c$ من C.L. العمود الاوسط و تمتد ركبه فقط عند طرف الـcantilever .



٩- يتم النظر عند الـ joints اذا وجد تباعد فى العزوم نكمل الحديد .
و اذا وجد تداخل فى العزوم يتم عمل مقص .

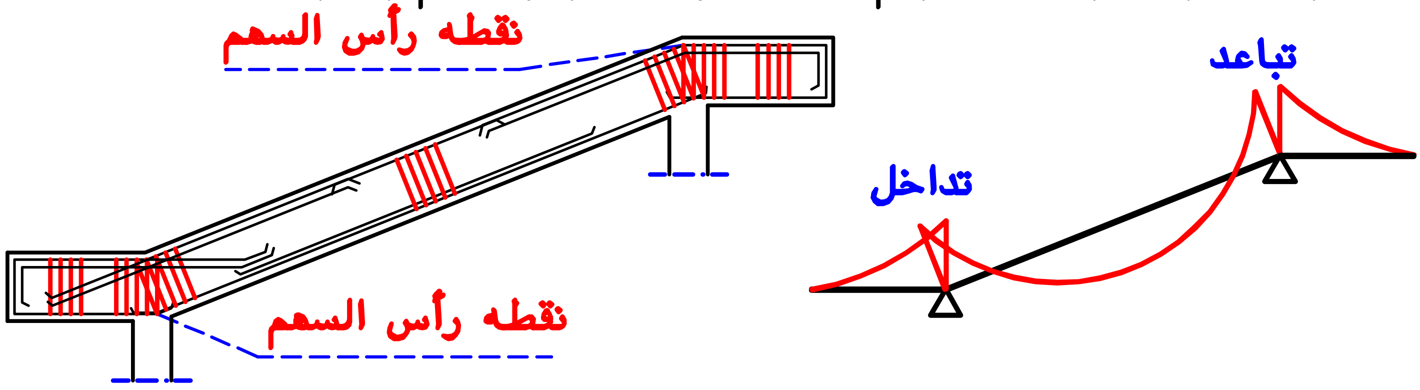


١٠- فى المنطقه الباقيه نمد تسليح Hangers stirrup
و يعمل تداخل مع التسليح الرئيسى مسافه 0.4 m على الطول المائل .



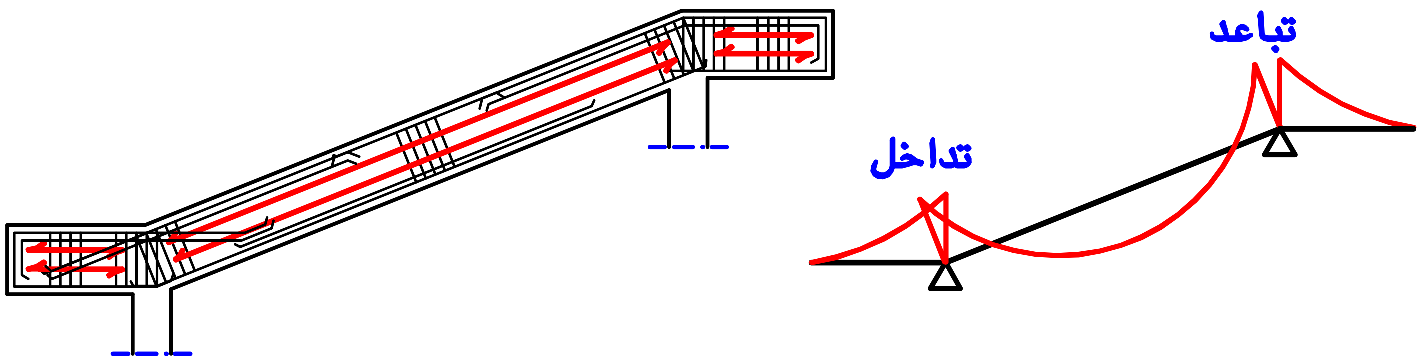
١١- نرسم الكانات عموديه على ال **C.L** الكمره .

و عند التباعد او التداخل نرسم الكانات من نقطه رأس السهم و عمودى على ال **C.L**

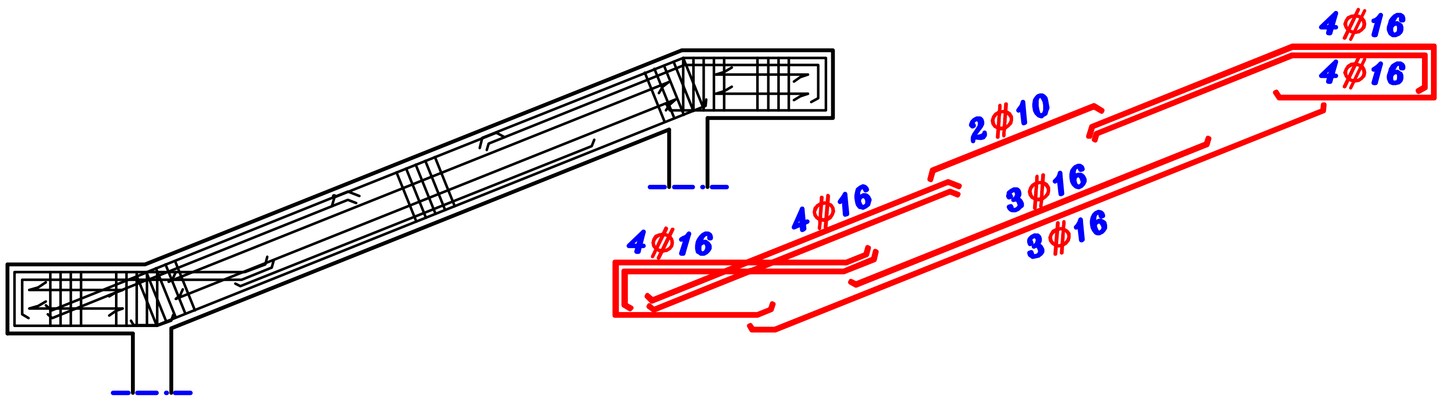


١٢- اذا كان عمق الكمره أكبر من *700 mm* نضع ***Shrinkage bars***

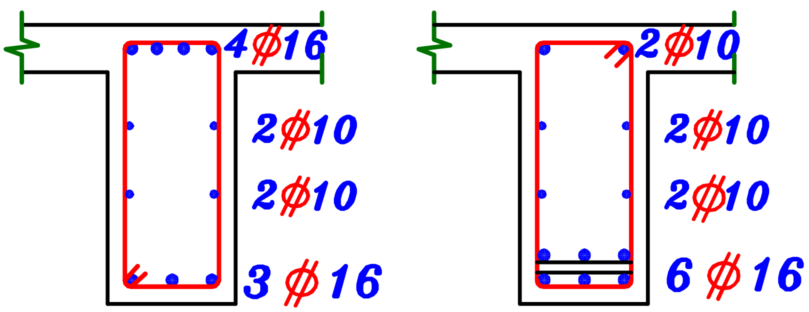
و تكون موازيه لـ **C.L** الكمره .

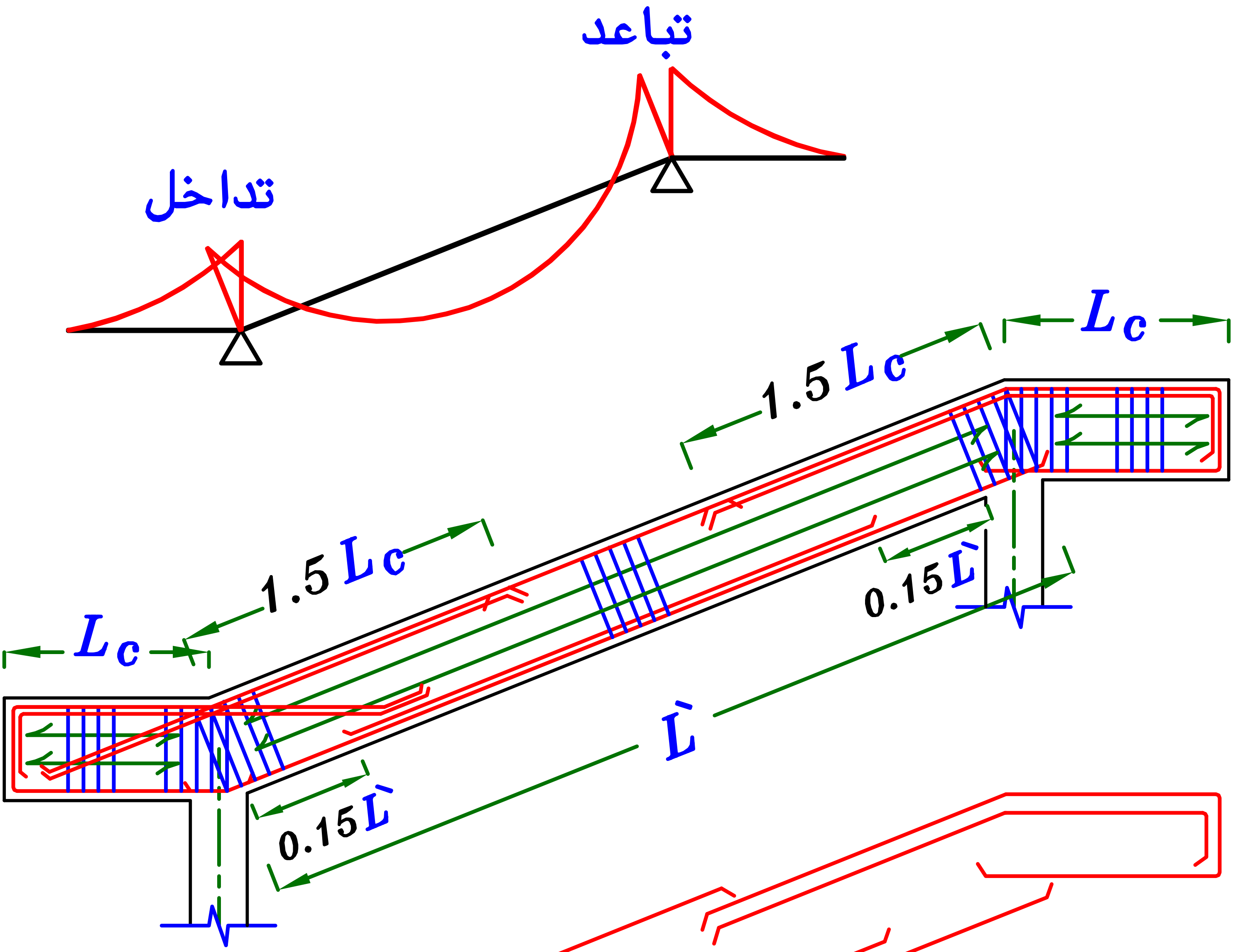


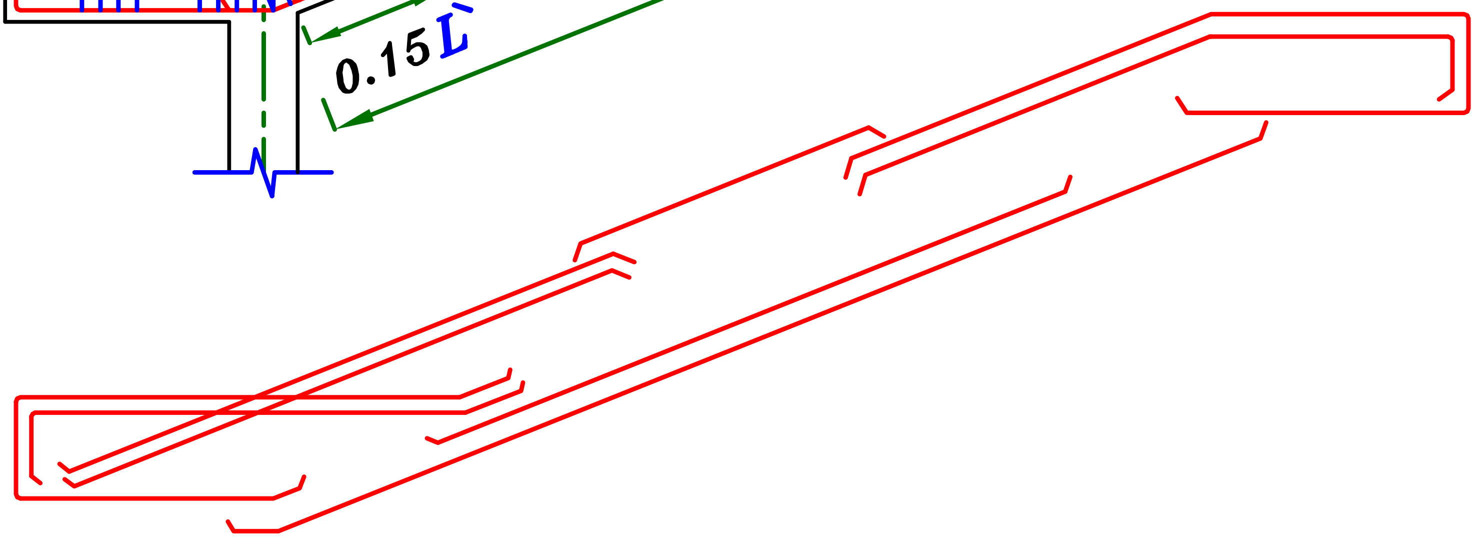
١٣- أسفل تسليح الكمره مباشره نرسم **التفريد** و يكون بنفس مقياس رسم الكمره



١٤- نرسم تسليح الكمره فى ***cross sections*** بمقياس رسم أكبر

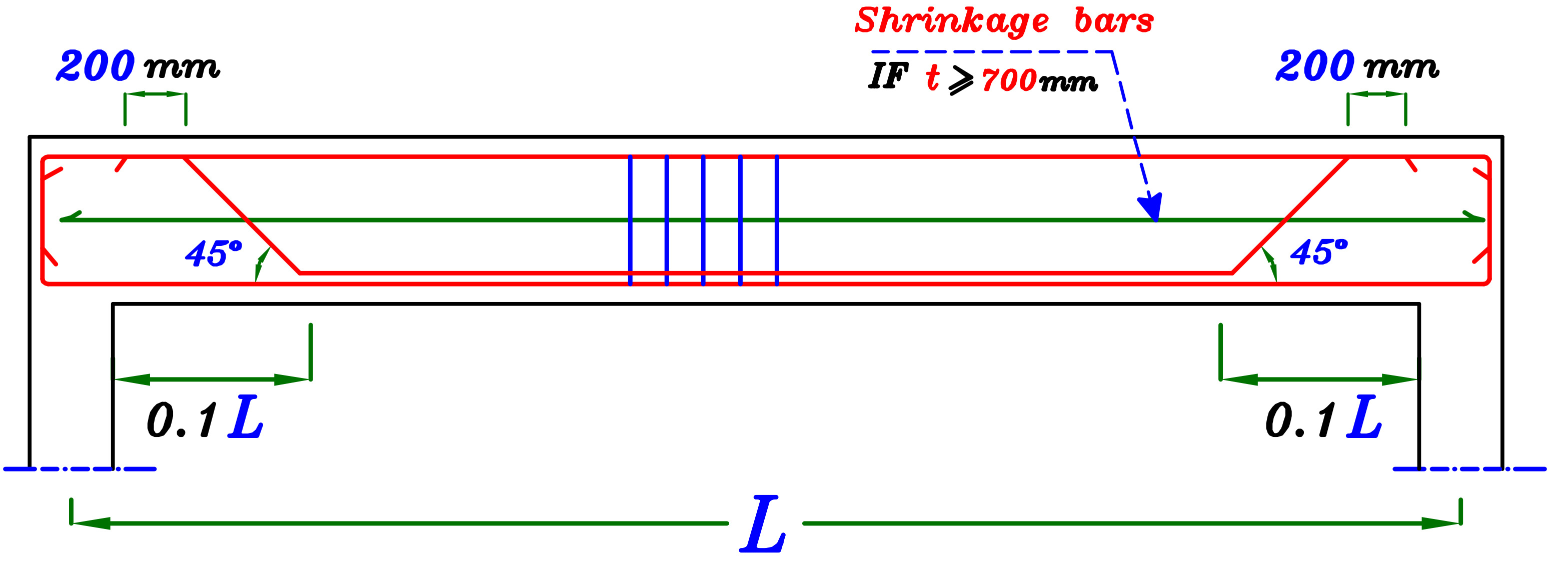


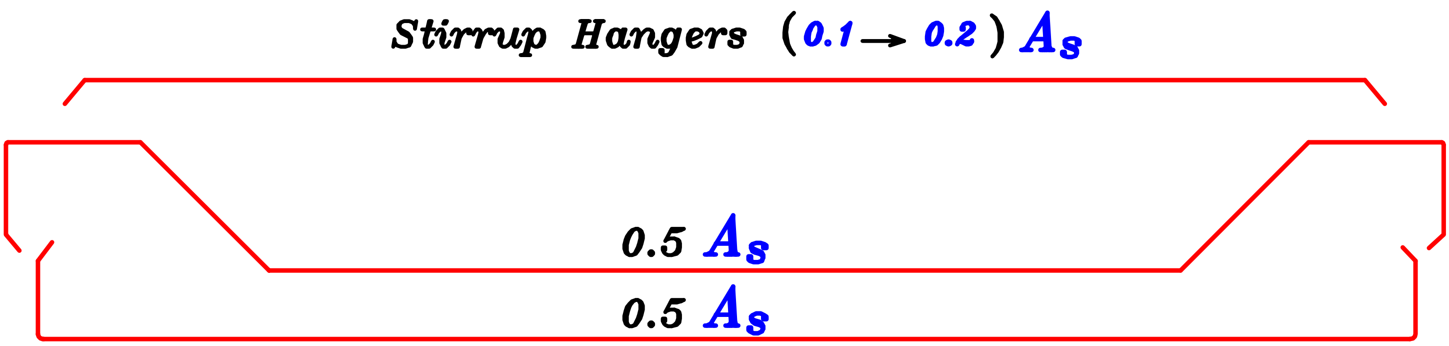

تباعد
تداخل
1.5 Lc
Lc
1.5 Lc
Lc
0.15 L`
0.15 L`
L`



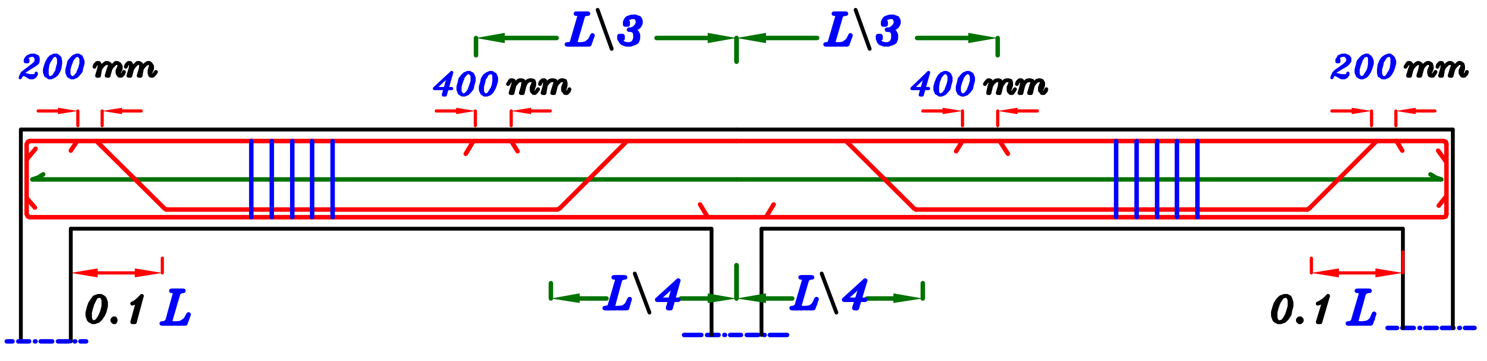
Bent Bars. الاسياخ المكسحه

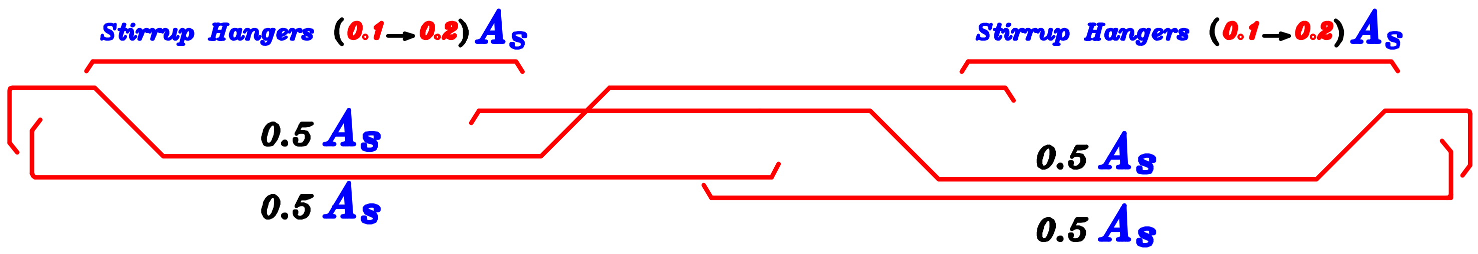
Simple Beam.



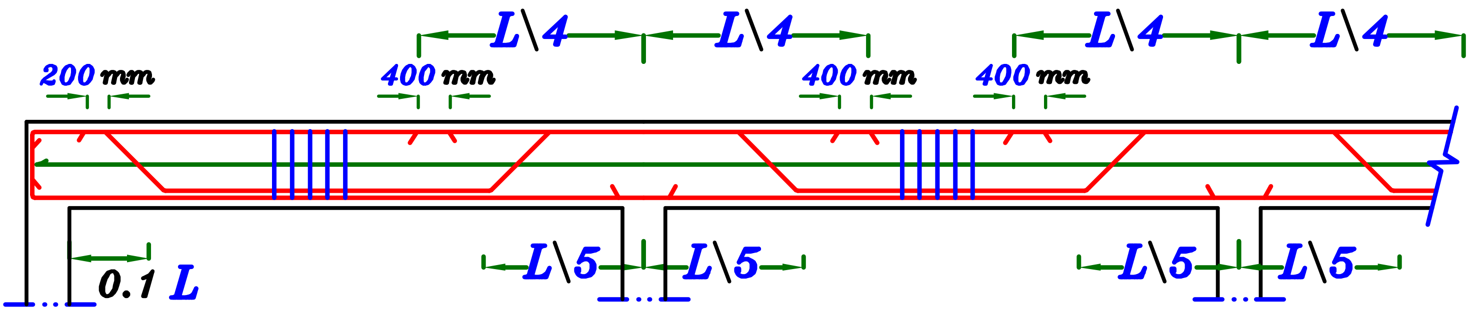


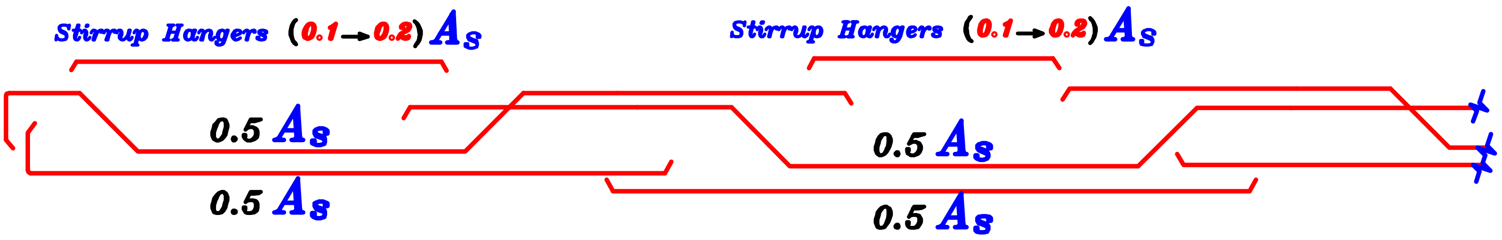
Continuous Beam (2 Spans)





Continuous Beam (More than 2 spans)





Example on Design Beams & Drawing RFT. using Empirical Method.

Example.

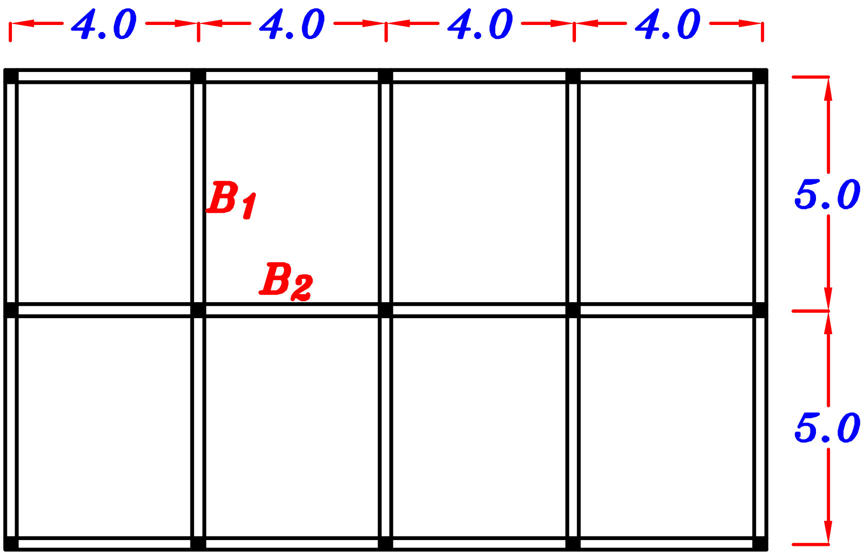
$F_{cu} = 25 \ N\backslash mm^2$

st. 360/520

$t_s = 140 \ mm$

$F.C. = 2.0 \ kN\backslash m^2$

$L.L. = 2.0 \ kN\backslash m^2$



Req.

1- Draw the absolute B.M.D. For beams B1 & B2

2- Design the critical sections For bending using charts.

3- Draw details of RFT. For Beams using Imperical Method.

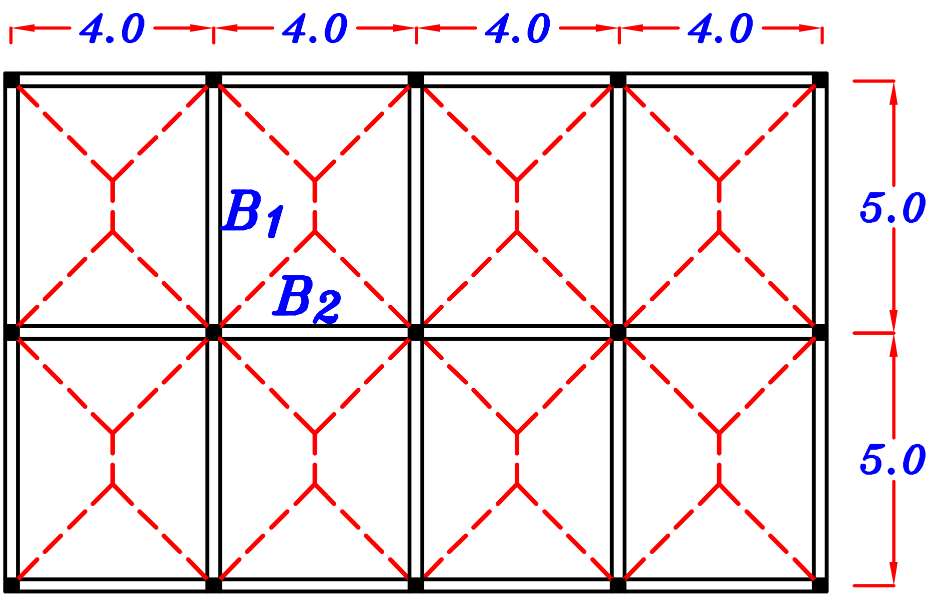
Solution.

∵ The Beams is continuos beams

∴ The cases of Loading is only T.L.

Take o.w. (beam) $= 3.0 \ kN\backslash m'$ (Working)

$w_s = t_s * \gamma_c + F.C. + L.L. = 0.14 * 25 + 2.0 + 2.0 = 7.50 \ kN\backslash m^2$



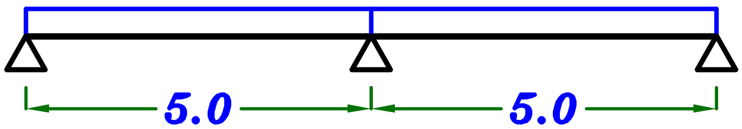
B_1

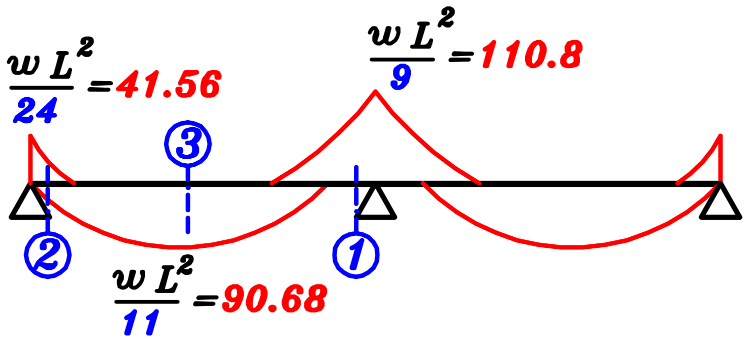
$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{5.0}\right)^2 = 0.7866$$

$$w_e = o.w. + 2\, C_e\, w_s\, \frac{L_s}{2} = 3.0 + 2\,(0.7866)\,(7.50)\,\left(\frac{4}{2}\right) = 26.60 \ kN\backslash m'$$

$$(w_e)_{U.L.} = 1.50 * 26.60 = 39.90 \ kN\backslash m'$$

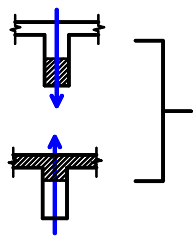
$w_e = 39.90 \ kN\backslash m'$





Sec. ① $M_{U.L.} = 110.8$ kN.m R–Sec.

Sec. ③ $M_{U.L.} = 90.68$ kN.m T–Sec.



$\because \; M_T < 2\, M_R$

$\therefore$ Design R–Sec. at First.

Sec. ① $M_{U.L.} = 110.8$ kN.m R–Sec.

– Take C_1 between $(3.0 \longrightarrow 4.0)$ $\quad C_1 = 3.50$

– From charts $C_1 = 3.50 \longrightarrow J = 0.78$

– Get $d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} = 3.50 \sqrt{\frac{110.8 * 10^6}{25 * 250}} = 466.0$ mm

– Take $\boxed{d = 500 \text{ mm}}$, $\boxed{t = 550 \text{ mm}}$

– Get $A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{110.8 * 10^6}{0.78 * 360 * 466.0} = 846.7 \ mm^2$

- **Check $A_{s_{min.}}$** $\quad A_{s_{req.}} = 846.7 \ mm^2$

$$\mu_{min.} b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 500 = 390.6 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.} b\, d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 846.7 \ mm^2 \qquad 5 \phi 16$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{16 + 25} = 5.48 = 5.0$$

Sec. ② $\quad M_{U.L.} = 41.56 \ kN.m \quad$ R–Sec.

Take $d = 0.50 \ m$ (The same d of Sec. ①)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 500 = C_1 \sqrt{\frac{41.56 * 10^6}{25 * 250}} \longrightarrow C_1 = 6.13$$

- From Charts. $C_1 = 6.13 > 4.85 \longrightarrow J = 0.826$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{41.56 * 10^6}{0.826 * 360 * 500} = 279.5 \ mm^2$$

Check $A_{s_{min.}}$ $\quad A_{s_{req.}} = 279.5 \ mm^2$

$$\mu_{min.} b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 500 = 390.6 \ mm^2$$

$$\therefore \mu_{min.} b\, d > A_{s_{req.}} \xrightarrow{\text{Use}} A_{s_{min.}}$$

$$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y} b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 500 = 390.6$$

$$1.3\, A_{s_{req.}} = 1.3 * 279.5 = 363.3$$

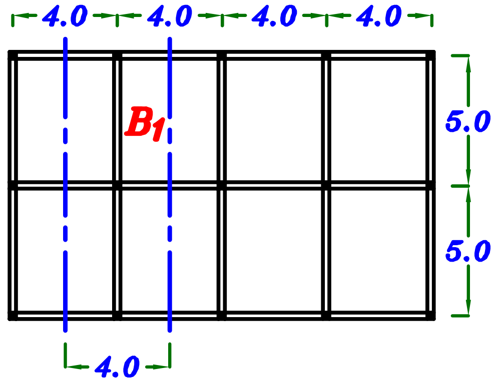
الأقل $= 363.3$

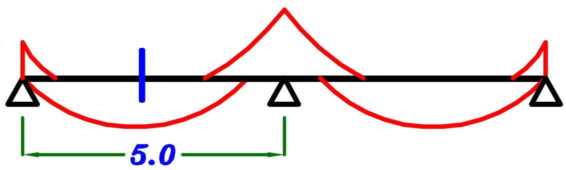
st. 360/520 $\quad \frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 250 * 500 = 187.5$

الأكبر $= 363.3 \ mm^2 \qquad 2 \phi 16$

Sec. ③ $M_{U.L.} = 90.68$ kN.m T−Sec.

Take $d = 0.50$ m (The same d of Sec. ①)





$$B = \begin{cases} C.L. - C.L. = 4.0 \text{ m} = 4000 \text{ mm} \\ 16\, t_s + b = 16 * 140 + 250 = 2490 \text{ mm} \\ K \dfrac{L}{5} + b = 0.8 * \dfrac{5000}{5} + 250 = 1050 \text{ mm} \end{cases}$$

$$\boxed{B = 1050 \text{ mm}}$$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, B}} \quad \therefore\ 500 = C_1 \sqrt{\frac{90.68 * 10^6}{25 * 1050}} \longrightarrow C_1 = 8.50$$

– From Charts. $C_1 = 8.50 > 4.85 \longrightarrow J = 0.826$

$$\therefore\ A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{90.68 * 10^6}{0.826 * 360 * 500} = 609.9 \text{ mm}^2$$

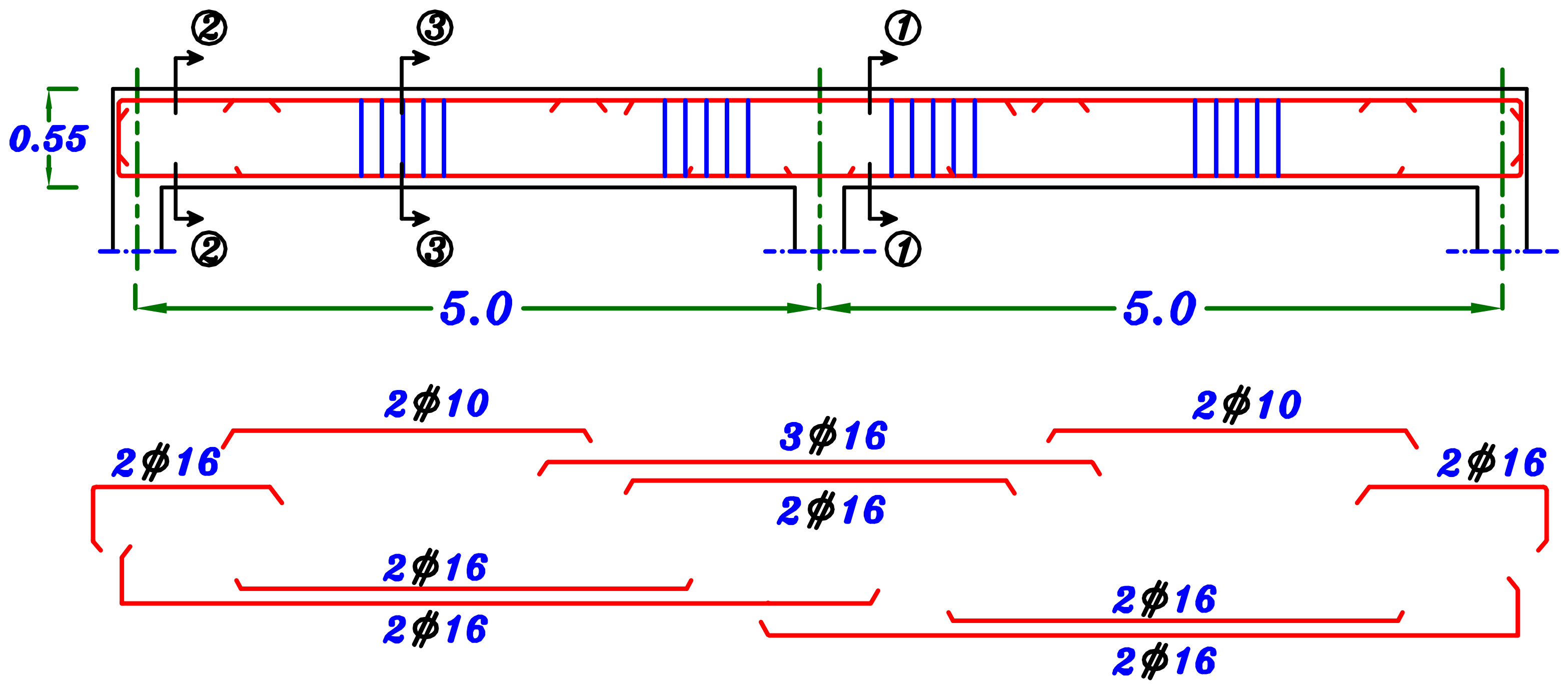
– Check $A_{s_{min.}}$ $\quad A_{s_{req.}} = 609.9 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 500 = 390.6 \text{ mm}^2$$

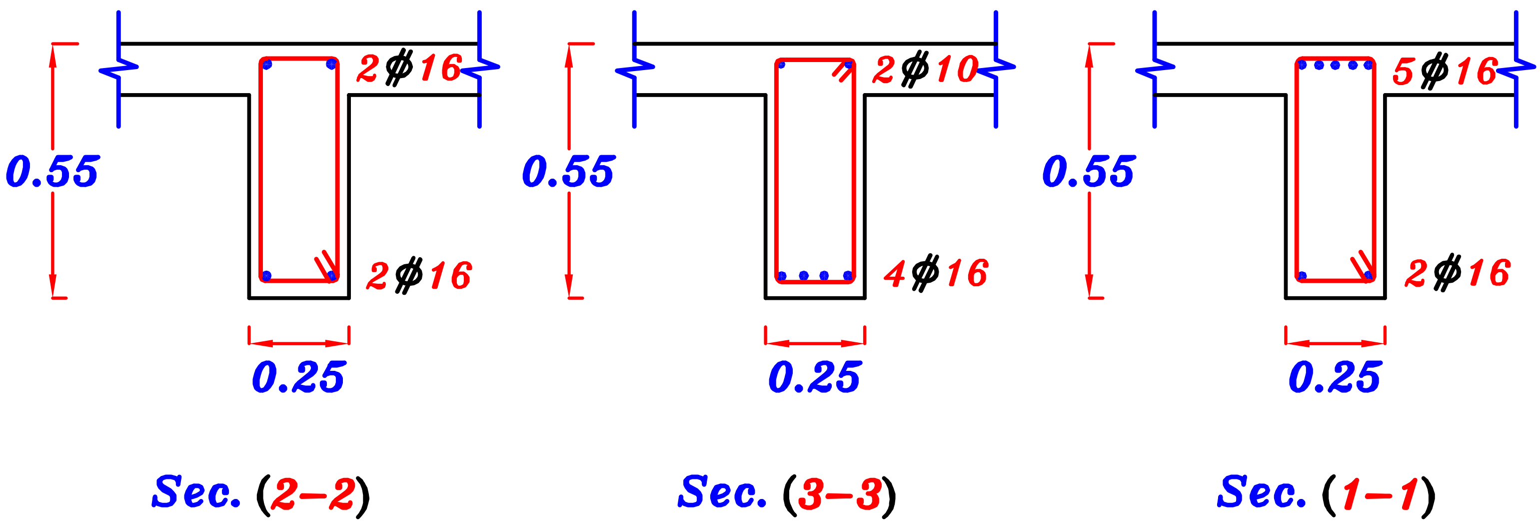
$$\therefore\ A_{s_{req.}} > \mu_{min.}\, b\, d$$

$$\therefore\ \text{Take } A_s = A_{s_{req.}} = 609.9 \text{ mm}^2 \qquad 4\,\phi\,16$$

RFT. of B_1



②
③
①
0.55
5.0
5.0
2ϕ10
3ϕ16
2ϕ10
2ϕ16
2ϕ16
2ϕ16
2ϕ16
2ϕ16
2ϕ16
2ϕ16



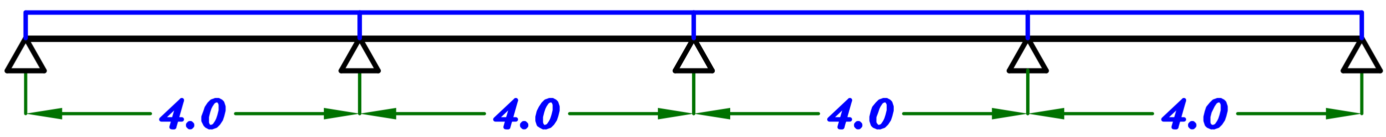
0.55
2ϕ16
2ϕ16
0.25
Sec. (2–2)
0.55
2ϕ10
4ϕ16
0.25
Sec. (3–3)
0.55
5ϕ16
2ϕ16
0.25
Sec. (1–1)

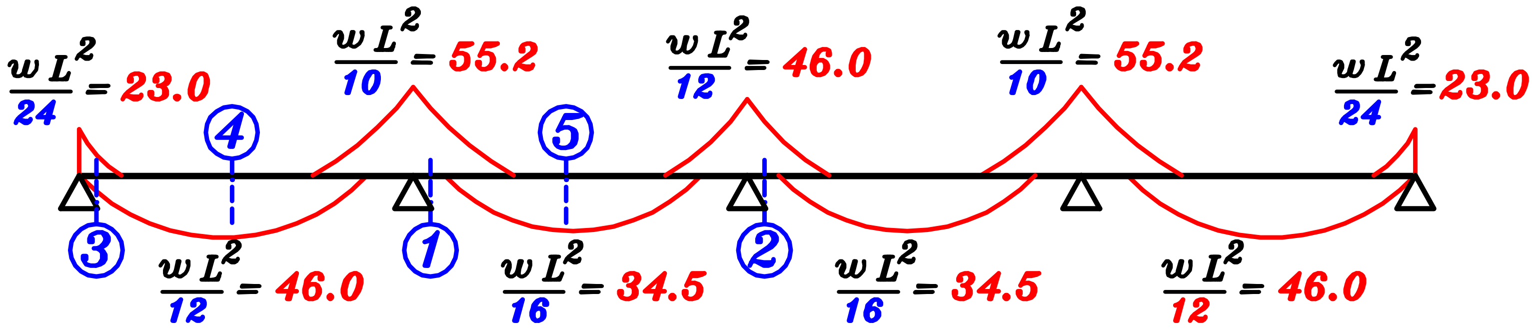
$\underline{\underline{B2}}$ $C_e = \frac{2}{3}$ For Triangles

$$w_e = o.w. + 2\,C_e\,w_s\,\frac{L_s}{2} = 3.0 + 2\left(\frac{2}{3}\right)(7.50)\left(\frac{4}{2}\right) = 23.0 \;\; kN\backslash m`$$

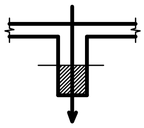
$$(w_e)_{U.L.} = 1.50 * 23.0 = 34.5 \;\; kN\backslash m`$$

$$w_e = 34.5 \;\; kN\backslash m`$$

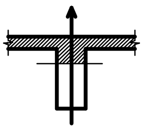




Sec. 1 $M_{U.L.} = 55.2$ kN.m R−Sec.



Sec. 4 $M_{U.L.} = 46.0$ kN.m T−Sec.



$\because\; M_T < 2\,M_R \quad \therefore$ Design R−Sec. at First.

$\underline{\underline{\text{Sec. 1}}}$ $M_{U.L.} = 55.2$ kN.m   R−Sec.

- Take C_1 between $(3.0 \longrightarrow 4.0)$ $C_1 = 3.50$
- From charts $C_1 = 3.50 \longrightarrow J = 0.78$
- Get $d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\,b}} = 3.50 \sqrt{\frac{55.2 * 10^6}{25 * 250}} = 328.9$ mm
- Take $\boxed{d = 350 \text{ mm}}$, $\boxed{t = 400 \text{ mm}}$

$$A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{55.2 * 10^6}{0.78 * 360 * 328.9} = 597.7 \;\; mm^2$$

- **Check $A_{s_{min.}}$** $\qquad A_{s_{req.}} = 597.7\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 597.7\ mm^2 \qquad 6\phi12$$

$$\therefore n = \frac{b-25}{\phi+25} = \frac{250-25}{12+25} = 6.08 = 6.0$$

Sec. ②

$$M_{U.L.} = 46.0\ kN.m \qquad R\text{–}Sec.$$

Take $d = 0.35\ m$ (The same d of Sec. ①)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 350 = C_1 \sqrt{\frac{46.0 * 10^6}{25 * 250}} \longrightarrow C_1 = 4.08$$

- From Charts. $C_1 = 4.04 \longrightarrow J = 0.805$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{46.0 * 10^6}{0.805 * 360 * 350} = 453.51\ mm^2$$

- **Check $A_{s_{min.}}$** $\qquad A_{s_{req.}} = 453.51\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 453.51\ mm^2 \qquad 4\phi12$$

Sec. ③ $M_{U.L.} = 23.0$ kN.m R–Sec.

Take $d = 0.35$ m (The same d of Sec. ①)

$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 350 = C_1 \sqrt{\frac{23.0 * 10^5}{25 * 250}} \longrightarrow C_1 = 5.77$

– From Charts. $C_1 = 5.77 > 4.85 \longrightarrow J = 0.826$

$$\therefore A_S = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{23.0 * 10^6}{0.826 * 360 * 350} = 221.0\ mm^2$$

Check $A_{s_{min.}}$ $A_{s_{req.}} = 221.0\ mm^2$

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4\ mm^2$

$\therefore \mu_{min.}\, b\, d > A_{s_{req.}} \xrightarrow{Use} A_{s_{min.}}$

$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\, b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4$

$1.3\ A_{s_{req.}} = 1.3 * 221.0 = 287.3$

الأقل $= 273.4$

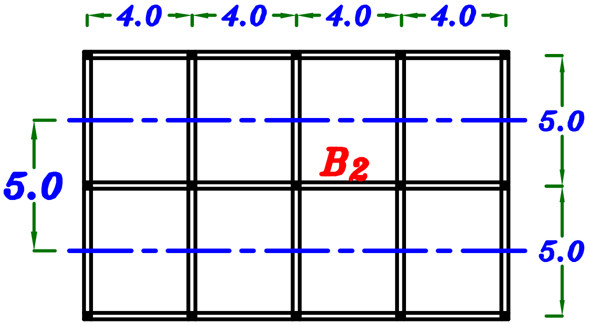
st. 360/520 $\frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 250 * 350 = 131.2$

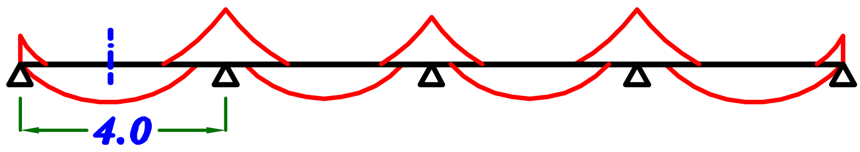
الأكبر $= 273.4\ mm^2$

3 ϕ 12

Sec. ④ $M_{U.L.} = 46.0$ kN.m T−Sec.

Take $d = 0.35$ m (The same d of Sec. ①)





$$B = \begin{cases} C.L.-C.L. = 5.0\ m = 5000\ mm \\ 16\ t_s + b = 16 * 140 + 250 = 2490\ mm \\ K\frac{L}{5} + b = 0.8 * \frac{4000}{5} + 250 = 890\ mm \end{cases} \qquad \boxed{B = 890\ mm}$$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\ B}} \quad \therefore\ 350 = C_1 \sqrt{\frac{46.0 * 10^6}{25 * 890}} \longrightarrow C_1 = 7.69$$

– From Charts $C_1 = 7.69 > 4.85 \longrightarrow J = 0.826$

$$\therefore\ A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{46.0 * 10^6}{0.826 * 360 * 350} = 442.0\ mm^2$$

– Check $A_{s_{min.}}$ $\qquad A_{s_{req.}} = 442.0\ mm^2$

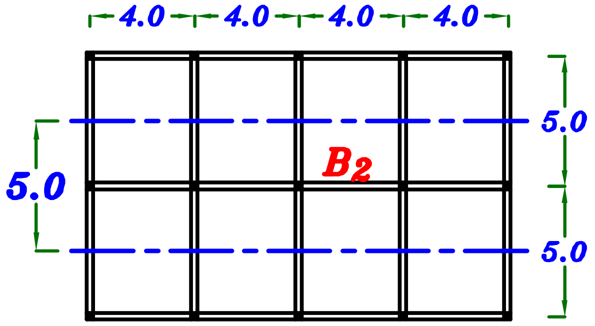
$$\mu_{min.}\ b\ d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\ d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4\ mm^2$$

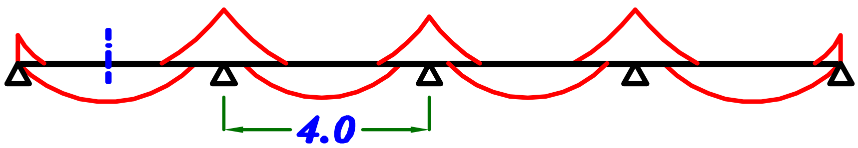
$$\therefore\ A_{s_{req.}} > \mu_{min.}\ b\ d$$

$\therefore$ Take $A_s = A_{s_{req.}} = 442.0\ mm^2$ $\quad$ 4 ϕ 12

Sec. 5 $M_{U.L.} = 34.5$ kN.m   T–Sec.

Take $d = 0.35$ m (The same d of Sec. 1)





$$B = \begin{cases} C.L. - C.L. = 5.0\ m = 5000\ mm \\ 16\, t_s + b = 16 * 140 + 250 = 2490\ mm \\ K \dfrac{L}{5} + b = 0.7 * \dfrac{4000}{5} + 250 = 810\ mm \end{cases}$$

$$\boxed{B = 810\ mm}$$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\ B}} \quad \therefore\ 350 = C_1 \sqrt{\frac{34.5 * 10^6}{25 * 810}} \longrightarrow C_1 = 8.48$$

– From Charts $\quad C_1 = 8.48 > 4.85 \longrightarrow J = 0.826$

$$\therefore\ A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{34.5 * 10^6}{0.826 * 360 * 350} = 331.5\ mm^2$$

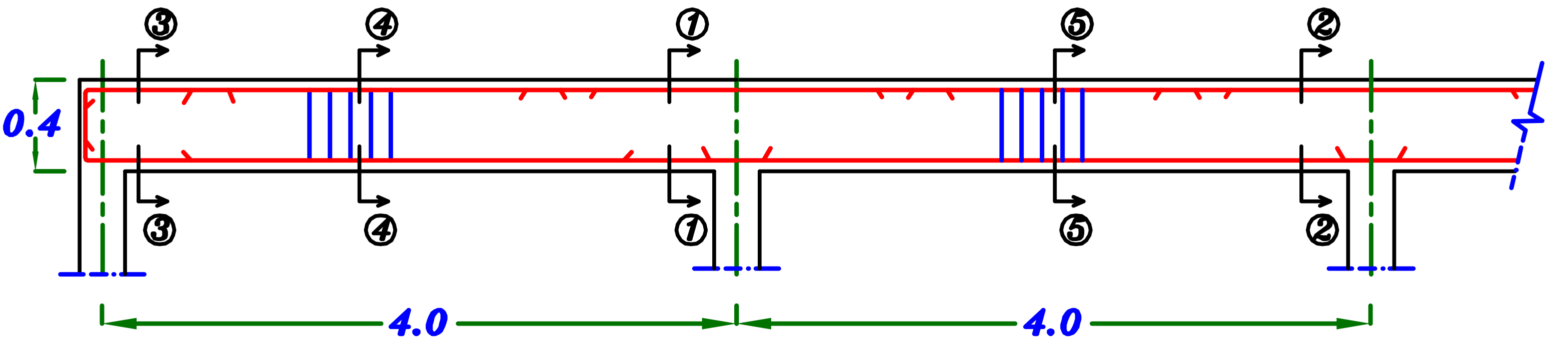
– Check $A_{s_{min.}}$ $\qquad A_{s_{req.}} = 331.5\ mm^2$

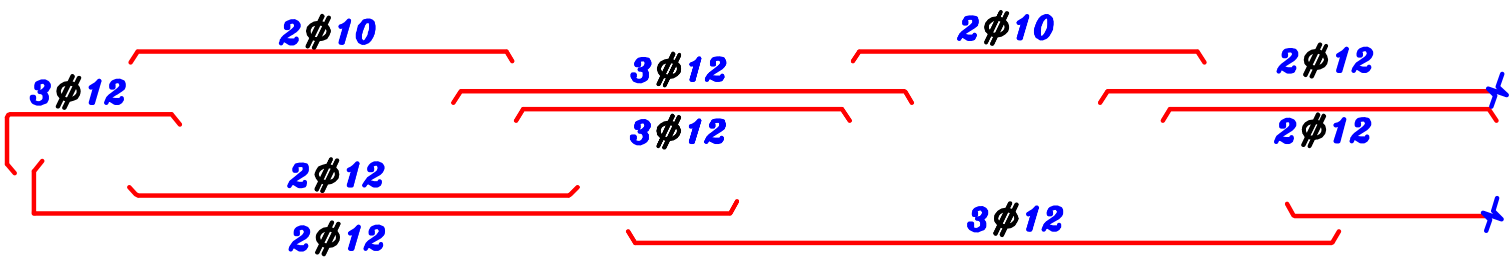
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4\ mm^2$$

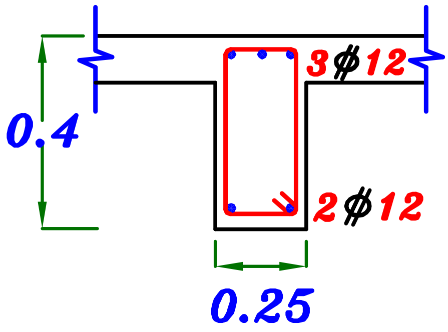
$$\therefore\ A_{s_{req.}} > \mu_{min.}\, b\, d$$

$\therefore$ Take $A_s = A_{s_{req.}} = 331.5\ mm^2$ $\quad$ 3 Ø 12

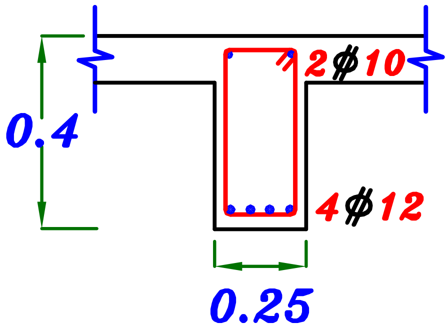
RFT. of B_2



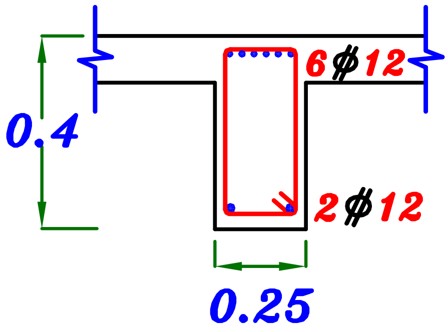




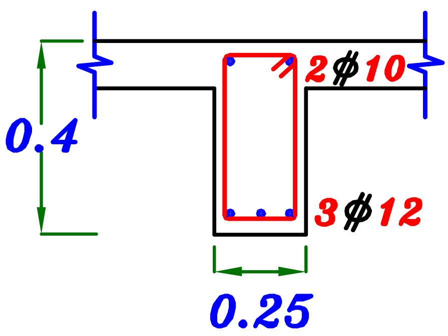
Sec. (3–3)



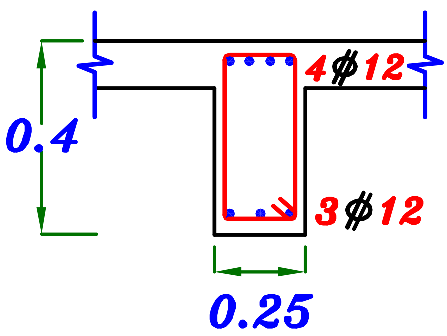
Sec. (4–4)



Sec. (1–1)

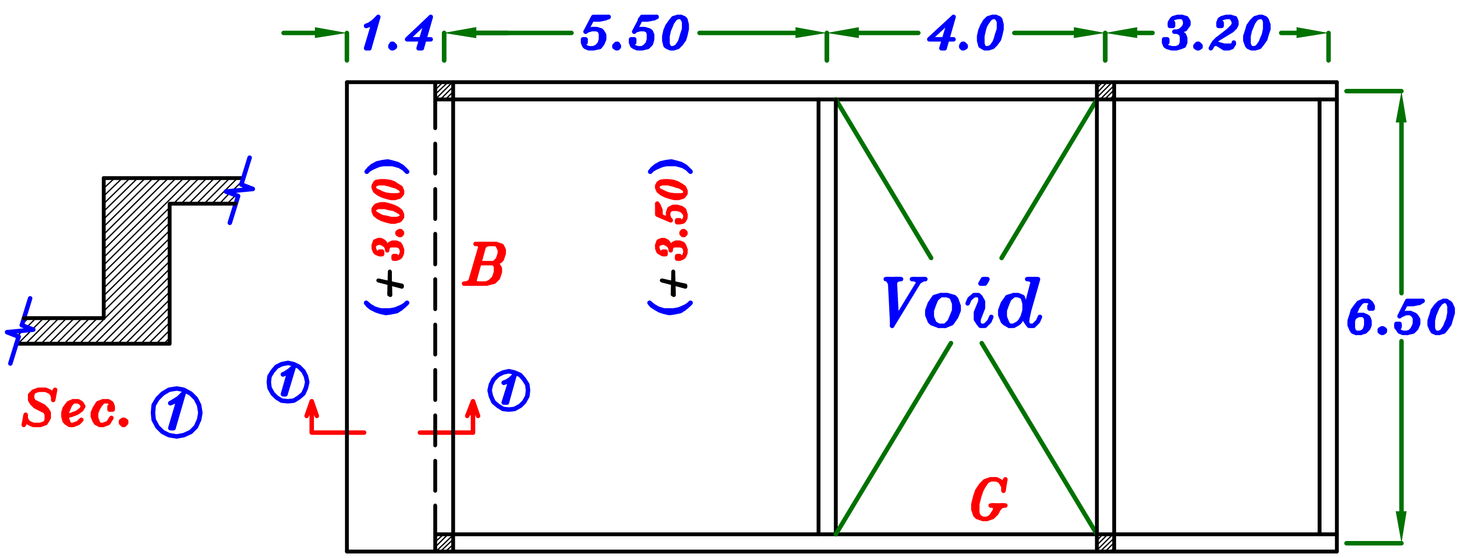


Sec. (5–5)



Sec. (2–2)

Example.



$F_{cu} = 25$ N\mm², st. 400/600 , $t_s = 150$ mm

F.C. = 2.0 kN\m² , L.L. = 3.0 kN\m²

Req.

1- Draw the absolute B.M.D. For beam B & Girder G

2- Design the critical sections For bending using charts.

3- Draw details of RFT. For Beams using Imperical Method.

Solution.

Take o.w. (beam) = 3.0 kN\m' (Working)

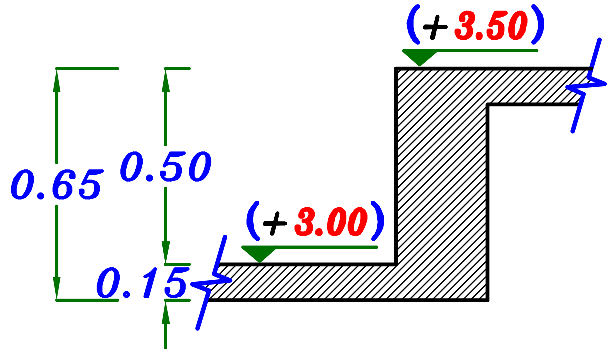
Take o.w. (girder) = 5.0 kN\m' (Working)

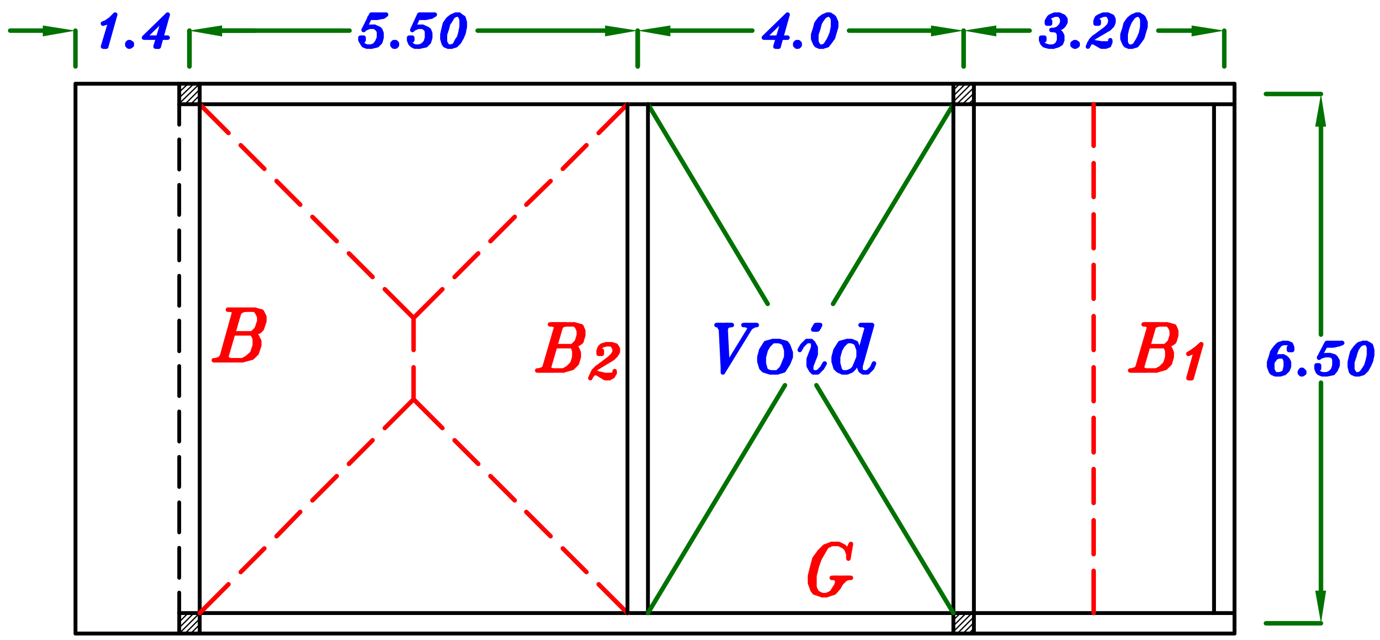
$g_s = t_s * \gamma_c + F.C. = 0.15 * 25 + 2.0 = 5.75$ kN\m²

$p_s = L.L. = 3.0$ kN\m²

$\boxed{g_s = 5.75 \text{ kN\\m}^2}$, $\boxed{p_s = 3.0 \text{ kN\\m}^2}$

Depth of Beam B is given = 0.65 m





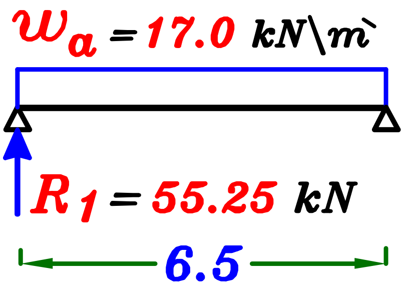
$\underline{B_1}$ Load For Shear = Load For Moment

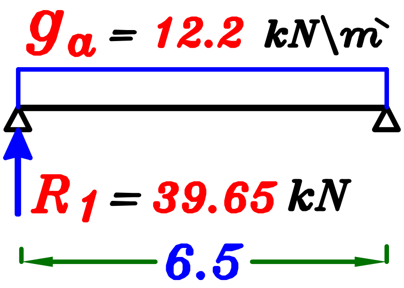
$$g_a = g_e = O.W. + g_s \frac{L_s}{2} = 3.0 + (5.75)\left(\frac{3.2}{2}\right) = 12.2 \ kN\backslash m'$$

$$p_a = p_e = p_s \frac{L_s}{2} = (3.0)\left(\frac{3.2}{2}\right) = 4.80 \ kN\backslash m'$$

$$w_a = w_e = g + p = 12.2 + 4.80 = 17.0 \ kN\backslash m'$$

$R_1 = 39.65$ kN --- D.L.
55.25 kN --- T.L.





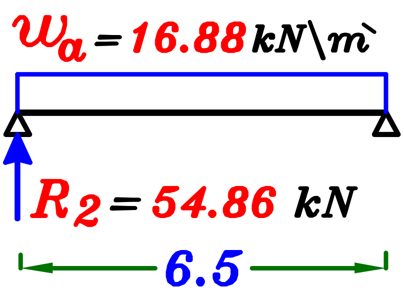
$\underline{B_2}$ For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.5}{6.5}\right) = 0.577$

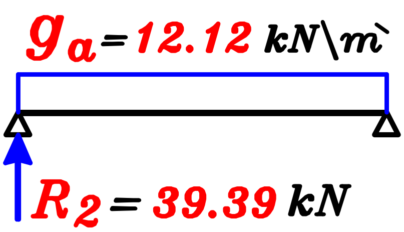
$$g_a = O.W. + C_a \, g_s \frac{L_s}{2} = 3.0 + (0.577)(5.75)\left(\frac{5.5}{2}\right) = 12.12 \ kN\backslash m'$$

$$p_a = C_a \, p_s \frac{L_s}{2} = (0.577)(3.0)\left(\frac{5.5}{2}\right) = 4.76 \ kN\backslash m'$$

$$w_a = g + p = 12.12 + 4.76 = 16.88 \ kN\backslash m'$$

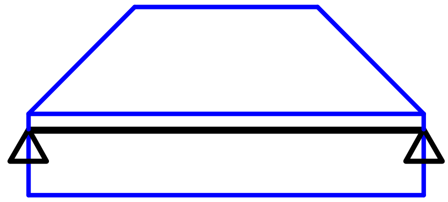
$R_2 = 39.39$ kN --- D.L.
54.86 kN --- T.L.





B

For Trapezoid



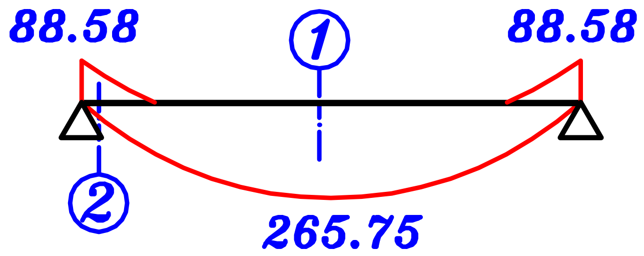
$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.5}{6.5}\right)^2 = 0.761$$

$$g_e = O.W. + g_s\, L_c + C_e\, g_s \frac{L_s}{2} = 3.0 + (5.75)(1.4) + (0.761)(5.75)\left(\frac{5.5}{2}\right) = 23.08 \ kN\backslash m'$$

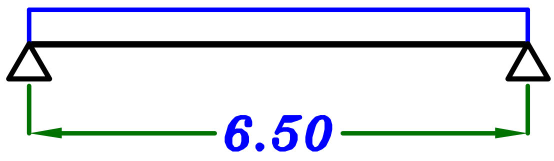
$$p_e = p_s\, L_c + C_e\, p_s \frac{L_s}{2} = (3.0)(1.4) + (0.761)(3.0)\left(\frac{5.5}{2}\right) = 10.47 \ kN\backslash m'$$

$$w_e = g_e + p_e = 23.08 + 10.47 = 33.55 \ kN\backslash m'$$

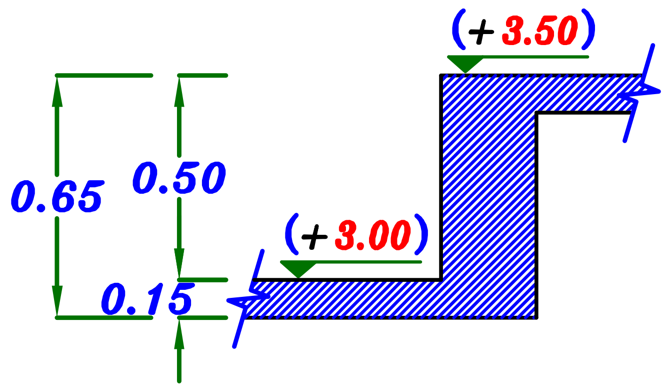
$$w_{U.L.} = 33.55 * 1.50 = 50.32 \ kN\backslash m'$$

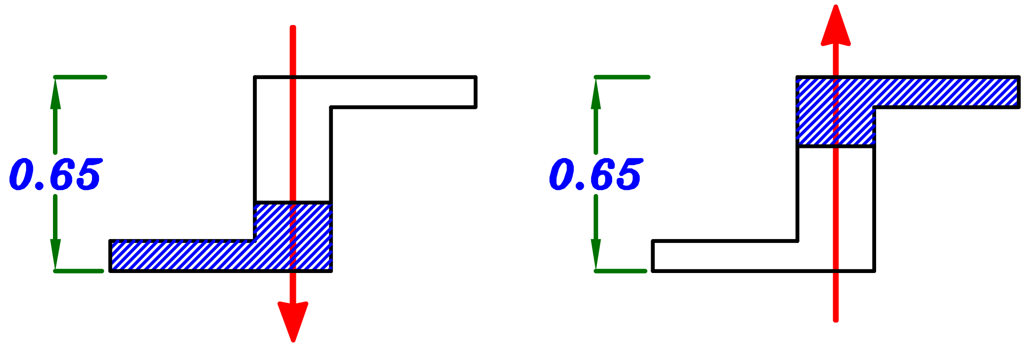


$$w_e = 50.32 \ kN\backslash m'$$



Depth Beam **B** is given $= 0.65$ m





Sec. 2 L-sec.

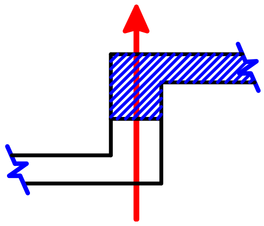
Sec. 1 L-sec.

ملحوظه

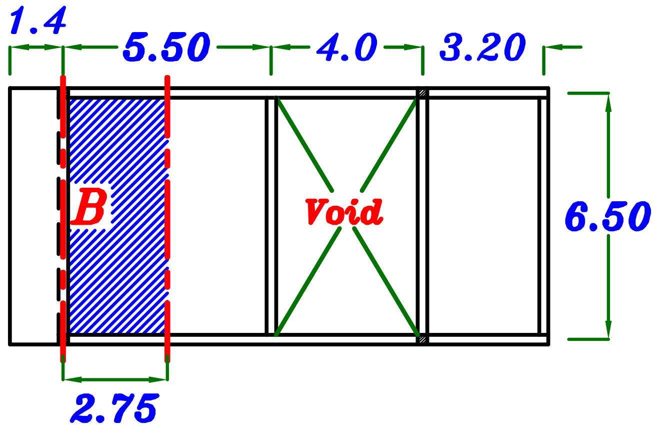
فى حاله أن عمق الكمره معطى ممكن تصميم أى قطاع قبل الاخر

Sec. ①

$M_{U.L.} = 265.75$ kN.m L-Sec.



Take $d = 0.60$ m (as given in Data.)



$$B = \begin{cases} C.L. - C.L. = \dfrac{5500}{2} = 2750 \text{ mm} \\ 6\, t_s + b = 6 * 150 + 250 = 1150 \text{ mm} \\ K \dfrac{L}{10} + b = 1.0 * \dfrac{6500}{10} + 250 = 900 \text{ mm} \end{cases} \qquad \boxed{B = 900 \text{ mm}}$$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, B}} \quad \therefore\ 600 = C_1 \sqrt{\frac{265.75 * 10^6}{25 * 900}} \longrightarrow C_1 = 5.52 \longrightarrow J = 0.826$$

$$\therefore\ A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{265.75 * 10^6}{0.826 * 400 * 600} = 1340.5 \text{ mm}^2$$

– **Check $A_{s_{min.}}$** $A_{s_{req.}} = 1340.5 \text{ mm}^2$

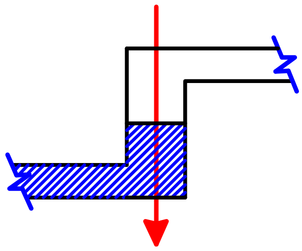
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 600 = 421.8 \text{ mm}^2$$

$$\therefore\ A_{s_{req.}} > \mu_{min.}\, b\, d$$

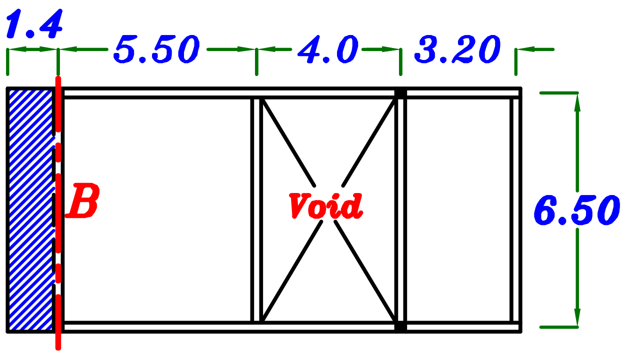
$$\therefore\ \text{Take } A_s = A_{s_{req.}} = 1340.5 \text{ mm}^2 \qquad 7\,\phi\,16$$

$$\therefore\ n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{16 + 25} = 5.48 = 5.0 \text{ bars}$$

Sec. ② $M_{U.L.} = 88.58$ kN.m **L−Sec.**



Take $d = 0.60$ m (as given in Data.)



كمره مقلوبه
$K = 0.15$

$$B = \begin{cases} C.L.-C.L. = 1.40\ m = 1400\ mm \\ 6\ t_s + b = 6 * 150 + 250 = 1150\ mm \\ K\dfrac{L}{10} + b = 0.15 * \dfrac{6500}{10} + 250 = 347.5\ mm \end{cases}$$

$$\boxed{B = 347.5\ mm}$$

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\ B}} \quad \therefore 600 = C_1 \sqrt{\frac{88.58 * 10^6}{25 * 347.5}} \longrightarrow C_1 = 5.94 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{88.58 * 10^6}{0.826 * 400 * 600} = 446.8\ mm^2$$

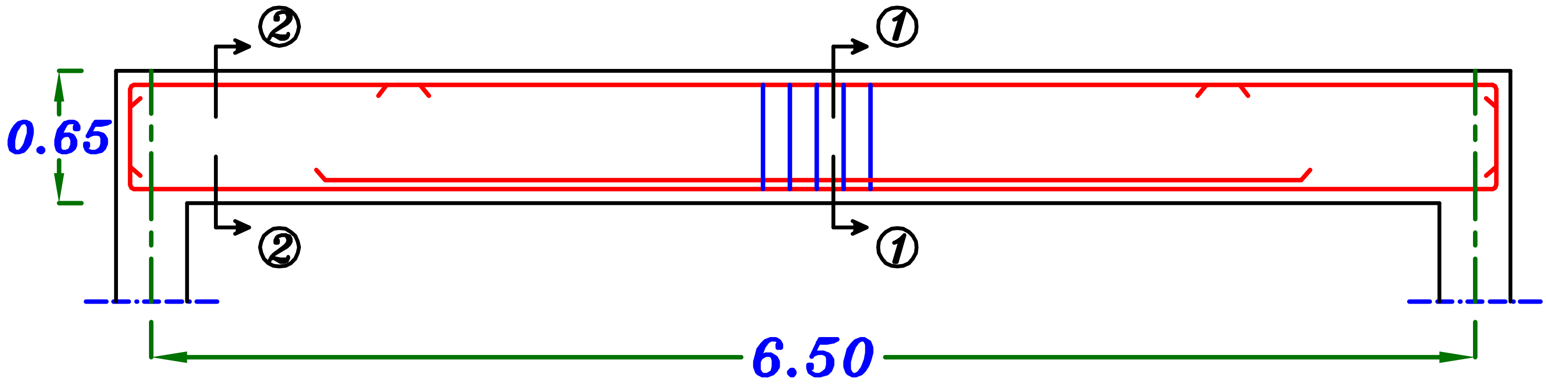
– Check $A_{s_{min.}}$ $A_{s_{req.}} = 446.8\ mm^2$

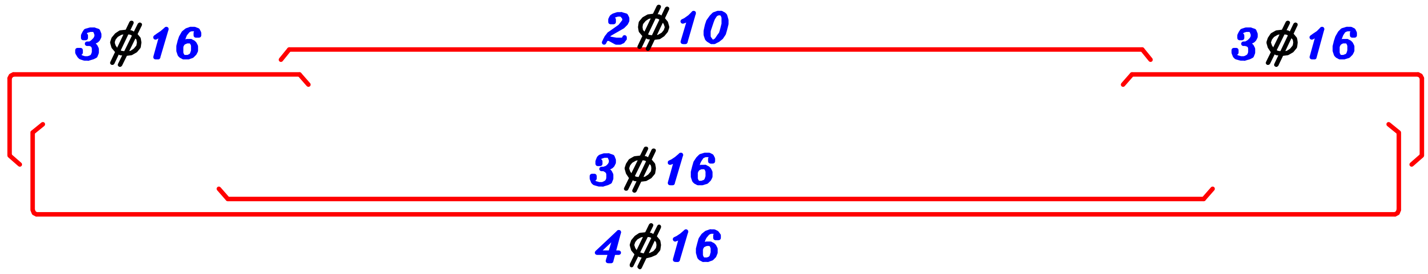
$$\mu_{min.}\ b\ d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\ d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 600 = 421.8\ mm^2$$

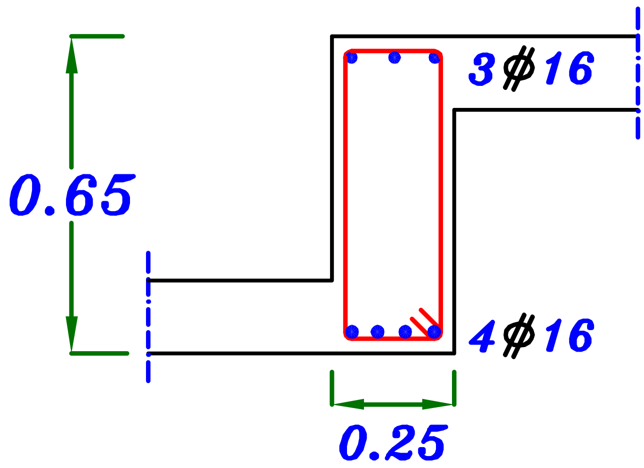
$$\therefore A_{s_{req.}} > \mu_{min.}\ b\ d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 446.8\ mm^2 \quad 3\phi16$$

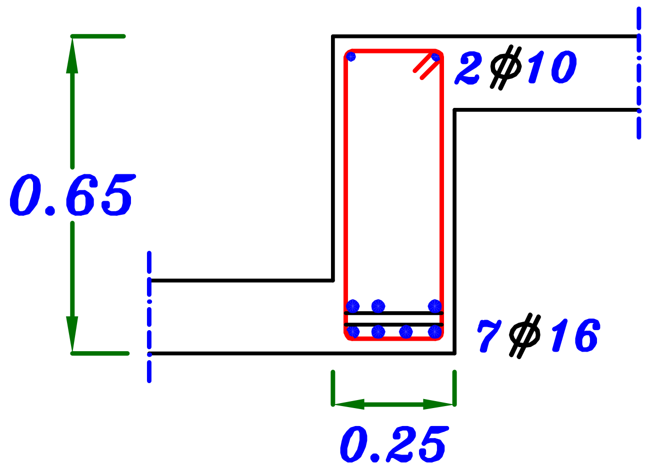
RFT. of B





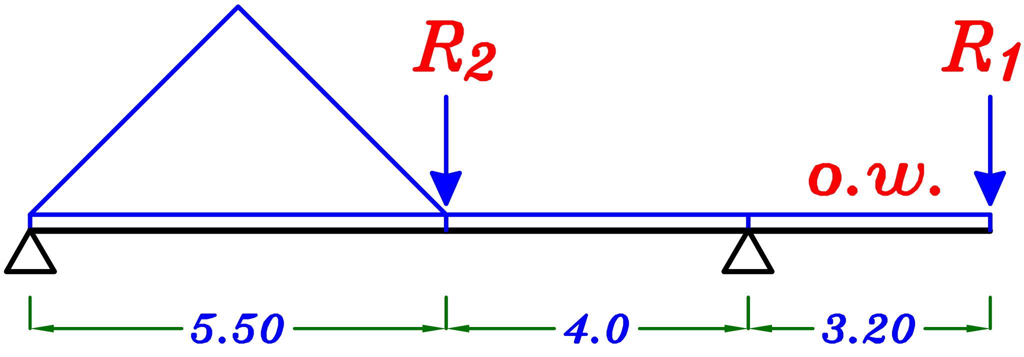


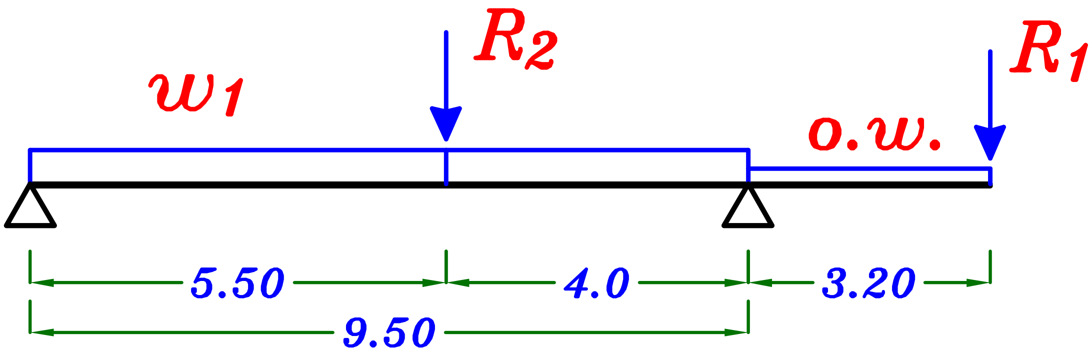
Sec. (2–2)



Sec. (1–1)

$\underline{\underline{G}}$





$$\frac{\sum area}{span} = \frac{\frac{1}{2}(5.50)\left(\frac{5.50}{2}\right)}{9.50} = 0.796$$

Load For Shear = Load For Moment

$$g_{1a} = g_{1e} = o.w. + \frac{\sum area}{span} * g_s = 5.0 + 0.796\ (5.75) = 9.577\ kN\backslash m'$$

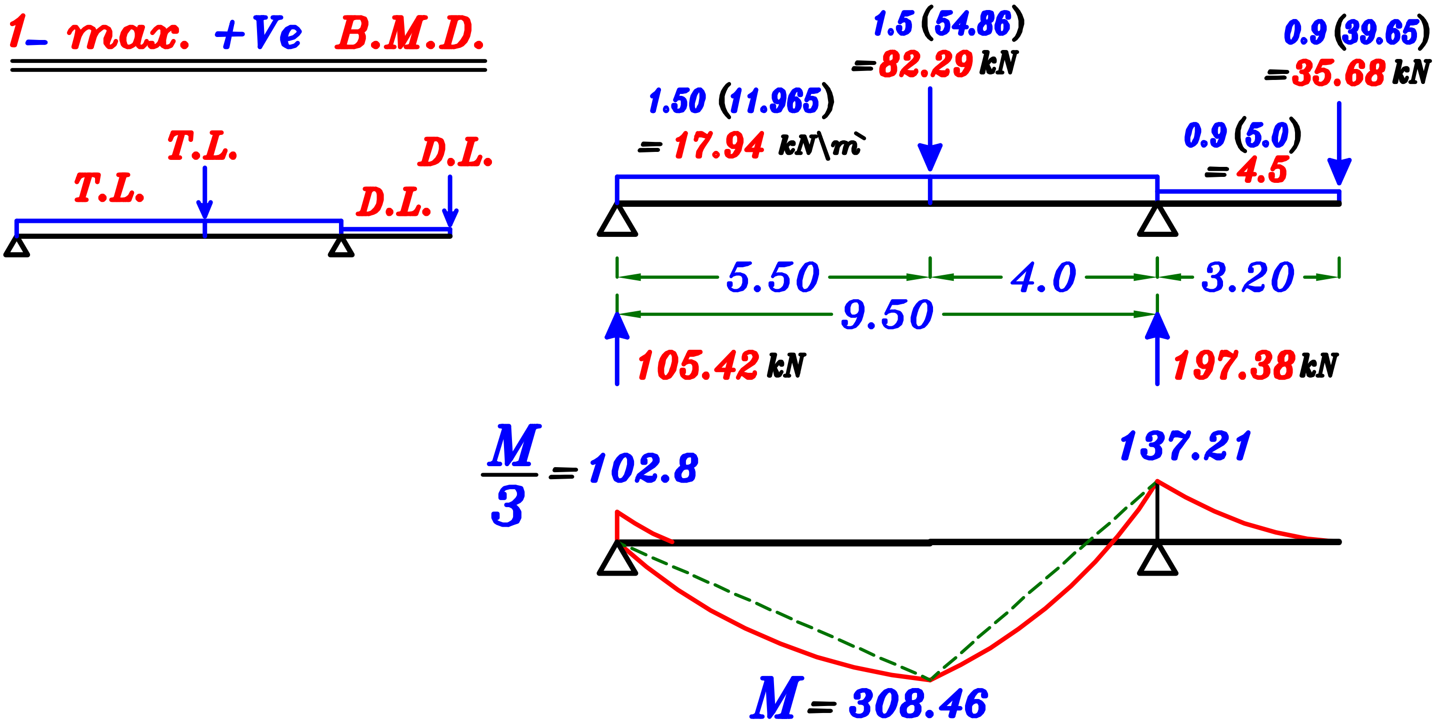
$$p_{1a} = p_{1e} = \frac{\sum area}{span} * p_s = 0.796\ (3.0) = 2.388\ kN\backslash m'$$

$$w_{1a} = w_{1e} = g_1 + p_1 = 9.577 + 2.388 = 11.965\ kN\backslash m'$$

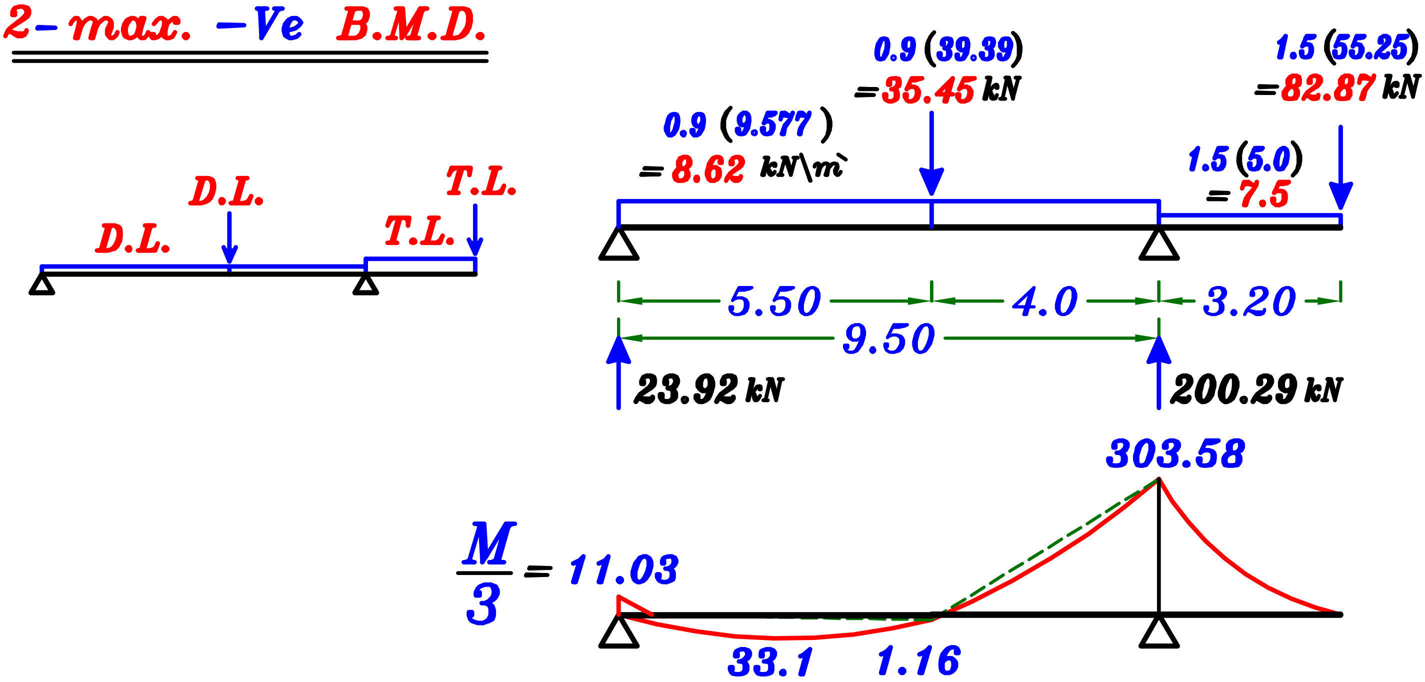
$$\boxed{\begin{array}{lll} g_1 = 9.577 & kN\backslash m' & \text{----- D.L.} \\ w_1 = 11.965 & kN\backslash m' & \text{----- T.L.} \end{array}}$$

max–max B.M.D. For the Girder (G)

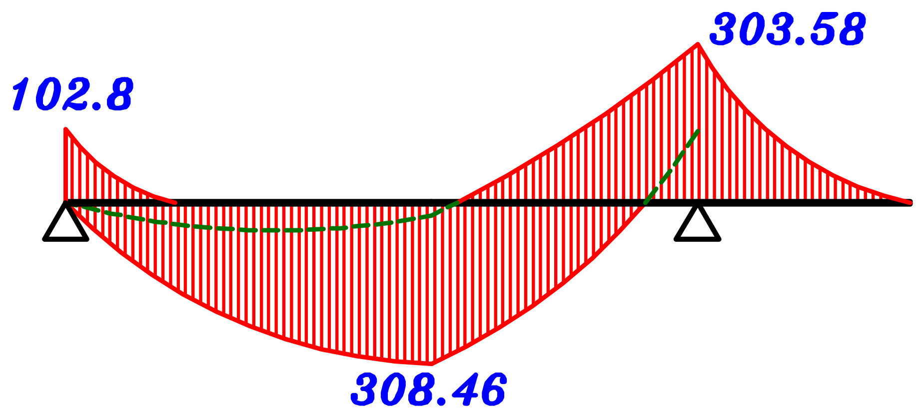
1- max. +Ve B.M.D.



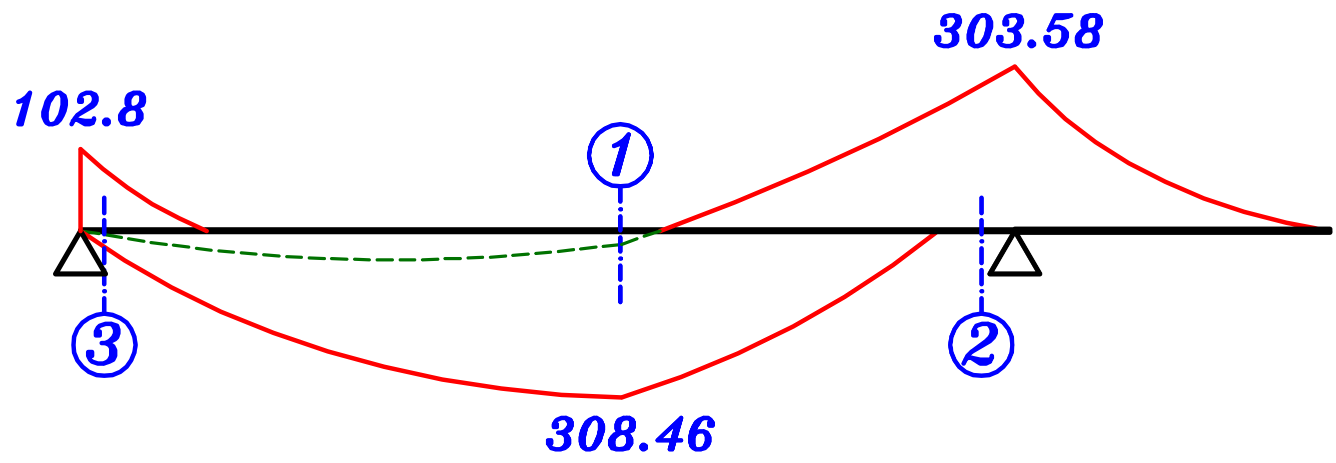
2- max. –Ve B.M.D.

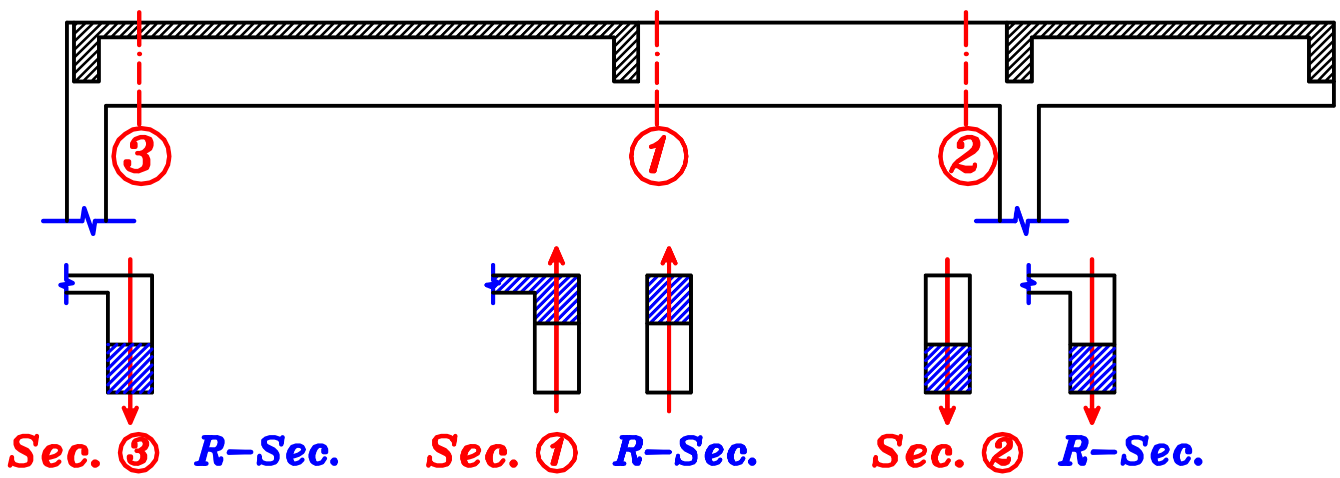


max–max B.M.D. For the Girder.



Design the critical sections For the Girder.





Sec. 1 $M_{U.L.} = 308.46$ kN.m R–Sec.

– Take C_1 between $(3.0 \longrightarrow 4.0)$ $C_1 = 3.50$

– From charts $C_1 = 3.50 \longrightarrow J = 0.78$

– Get $d = C_1 \sqrt{\dfrac{M_{U.L.}}{F_{cu}\, b}} = 3.50 \sqrt{\dfrac{308.46 * 10^6}{25 * 250}} = 777.5$ mm

– Take $\boxed{d = 800 \text{ mm}}$, $\boxed{t = 850 \text{ mm}}$

– Get $A_s = \dfrac{M_{U.L.}}{J\, F_y\, d} = \dfrac{308.46 * 10^6}{0.78 * 400 * 777.5} = 1271.5 \text{ mm}^2$

- **Check $A_{s_{min.}}$** $\qquad A_{s_{req.}} = 1271.5\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 800 = 562.5\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 1271.5\ mm^2 \qquad 5 \phi 20$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{20 + 25} = 5.0 \text{ bars}$$

Sec. ② $\qquad M_{U.L.} = 303.58\ kN.m \qquad$ R-Sec.

Take $d = 0.80\ m$ (The same d of Sec. ①)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \qquad \therefore 800 = C_1 \sqrt{\frac{303.58 * 10^6}{25 * 250}} \longrightarrow C_1 = 3.63 \longrightarrow J = 0.788$$

$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{303.58 * 10^6}{0.788 * 400 * 800} = 1203.9\ mm^2$$

- **Check $A_{s_{min.}}$** $\qquad A_{s_{req.}} = 1203.9\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 800 = 562.5\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$$

$$\therefore \text{Take } A_s = A_{s_{req.}} = 1203.9\ mm^2 \qquad 4 \phi 20$$

Sec. ③ $M_{U.L.} = 102.8$ kN.m   R–Sec.

Take $d = 0.80$ m (The same d of Sec. ①)

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore\ 800 = C_1 \sqrt{\frac{102.8 * 10^6}{25 * 250}} \longrightarrow C_1 = 6.23$$

– From Charts. $C_1 = 6.23 > 4.85 \longrightarrow J = 0.826$

$$\therefore\ A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{102.8 * 10^6}{0.826 * 400 * 800} = 388.9\ mm^2$$

Check $A_{s_{min.}}$ $A_{s_{req.}} = 388.9\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 800 = 562.5\ mm^2$$

$$\therefore\ \mu_{min.}\, b\, d > A_{s_{req.}} \xrightarrow{Use} A_{s_{min.}}$$

$$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\, b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 800 = 562.5$$

$$1.3\, A_{s_{req.}} = 1.3 * 388.9 = 505.6$$

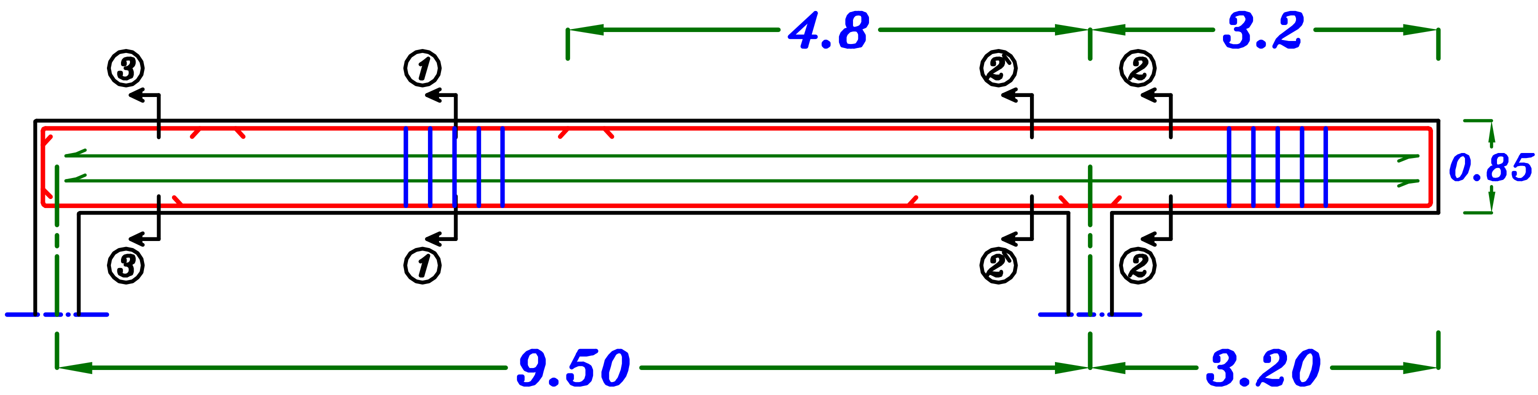
الأقل $= 505.6$

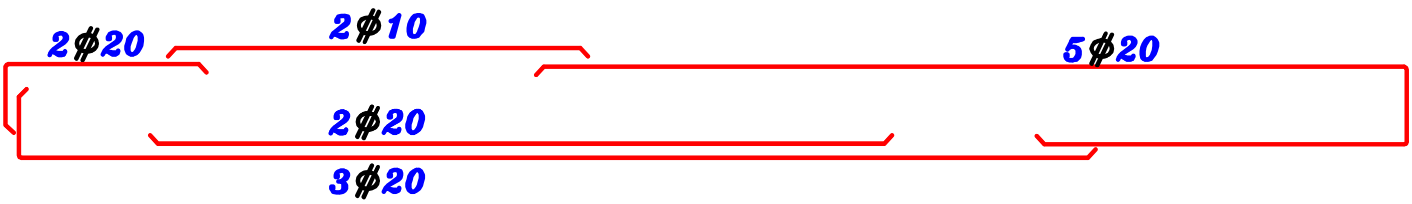
$$\text{st. } 400/600 \quad \frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 250 * 800 = 300$$

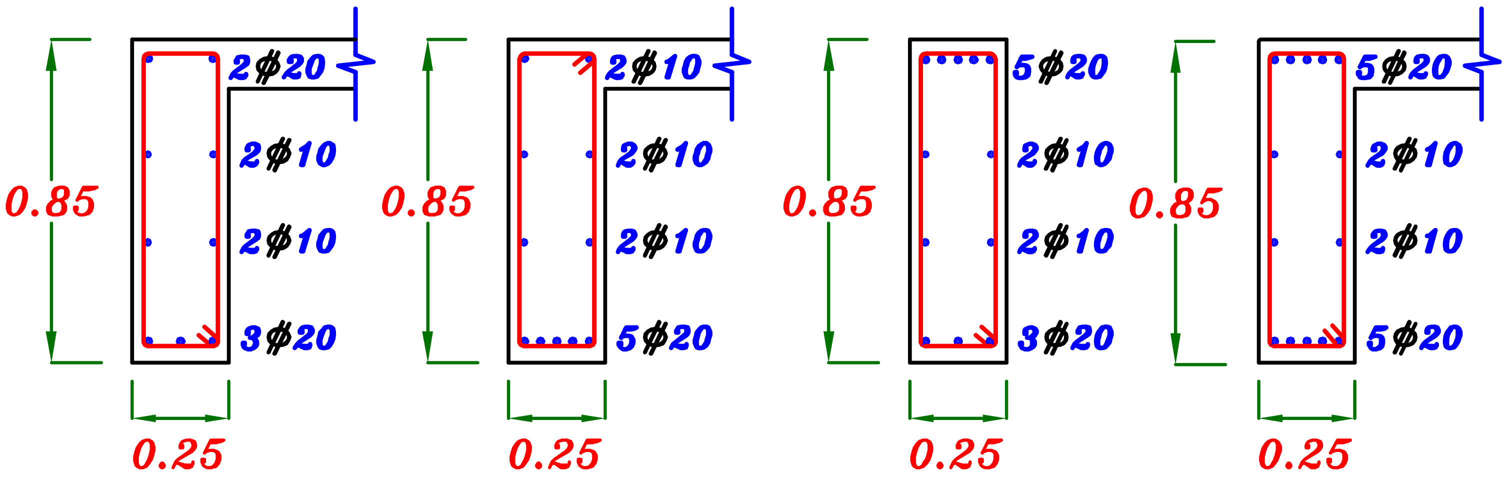
الأكبر $= 505.6\ mm^2$

2 ϕ 20

RFT. of G

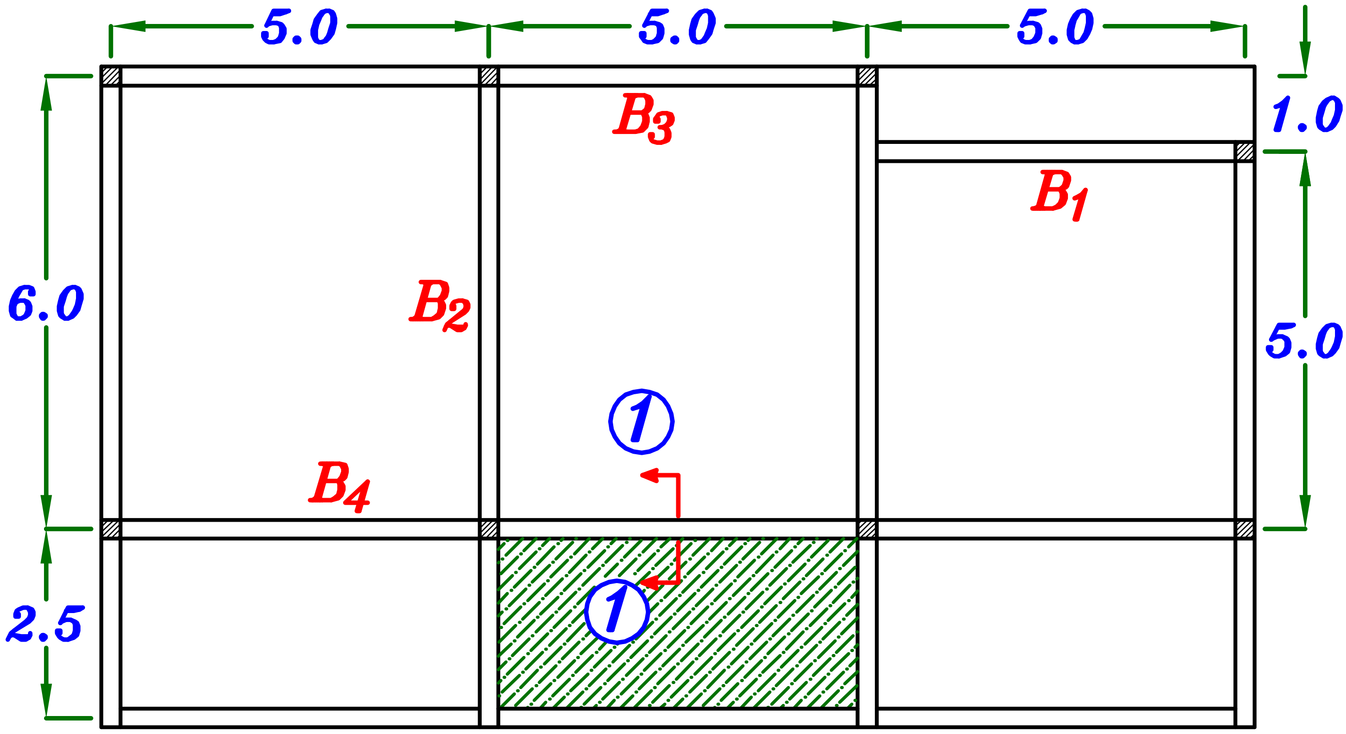


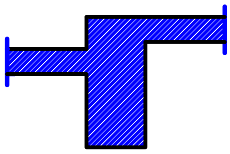




Sec. (3−3) Sec. (1−1) Sec. (2`−2`) Sec. (2−2)

Example.

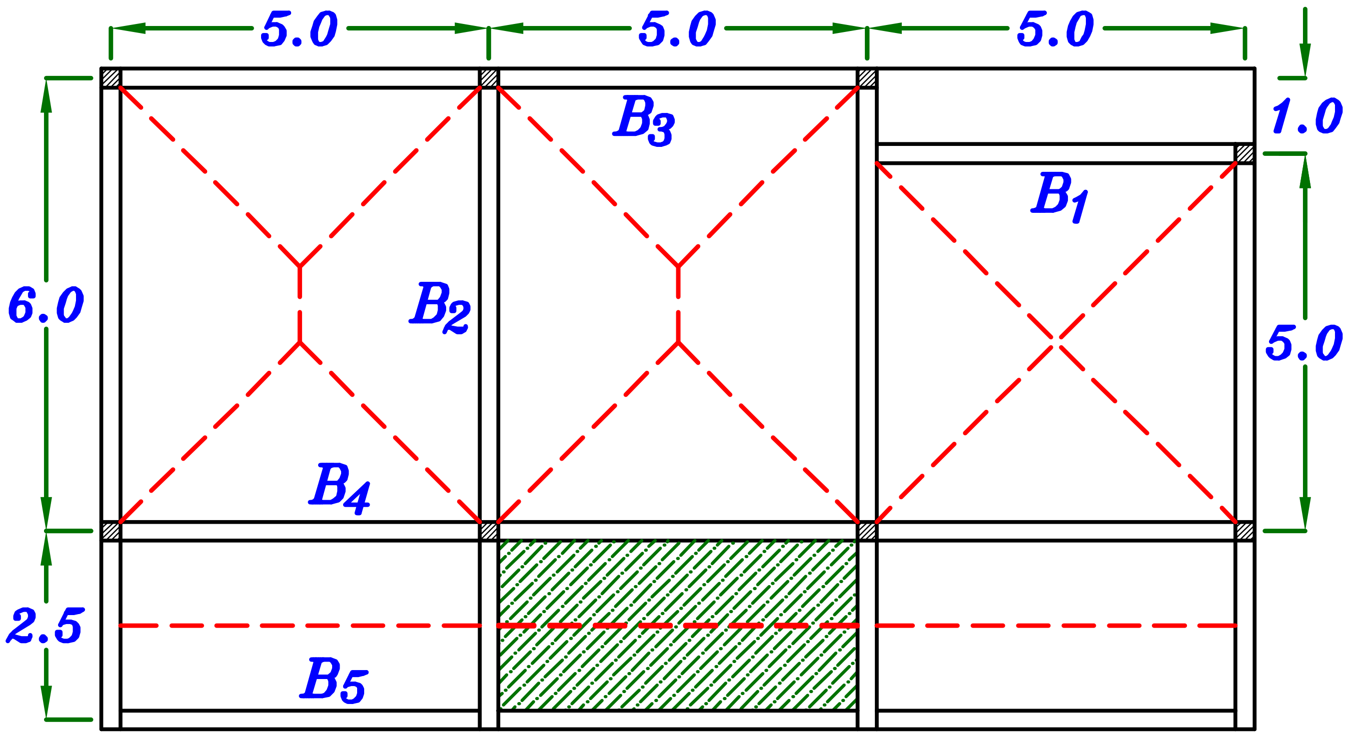




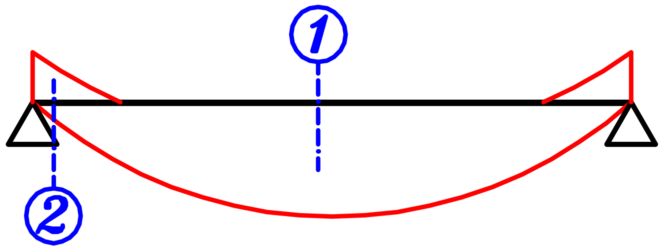
Sec.(1−1)

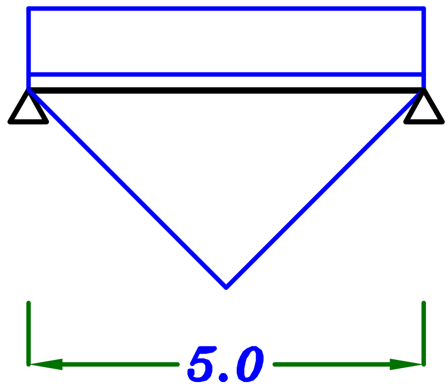
$F_{cu} = 25$ N\mm^2 , st. 400/600

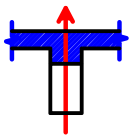
F.C. = 2.0 kN\m^2 , L.L. = 2.0 kN\m^2 , $t_s = 140$ mm

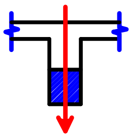


B_1





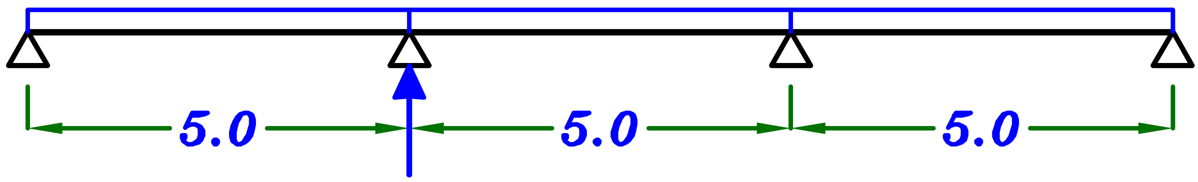
Sec. ① T-Sec.  K = 1.0

Sec. ② R-Sec. 

$\because M_T > 2\,M_R \quad \therefore$ Design T-Sec. at First.

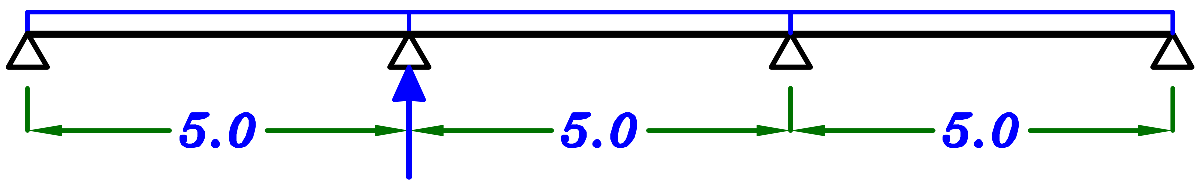
B_5

g_a



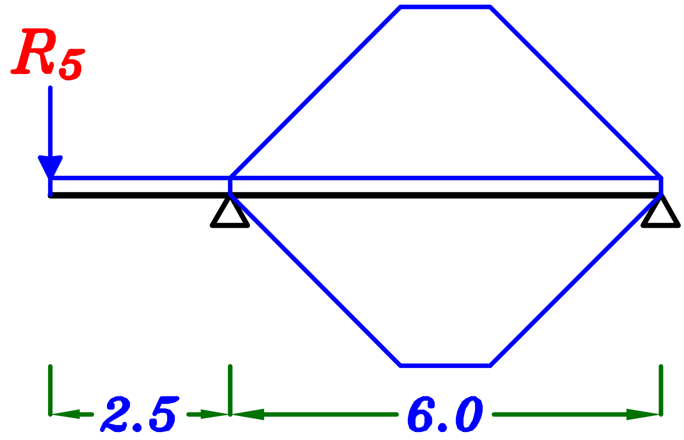
$\boxed{R_{5D} = 1.1\ g_a\ L}$

w_a

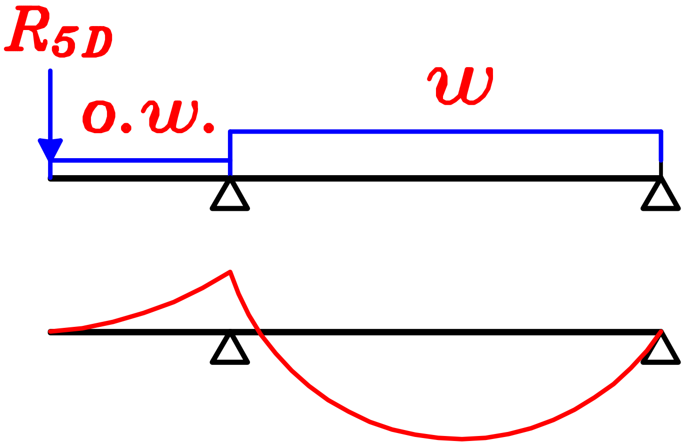


$\boxed{R_{5T} = 1.1\ w_a\ L}$

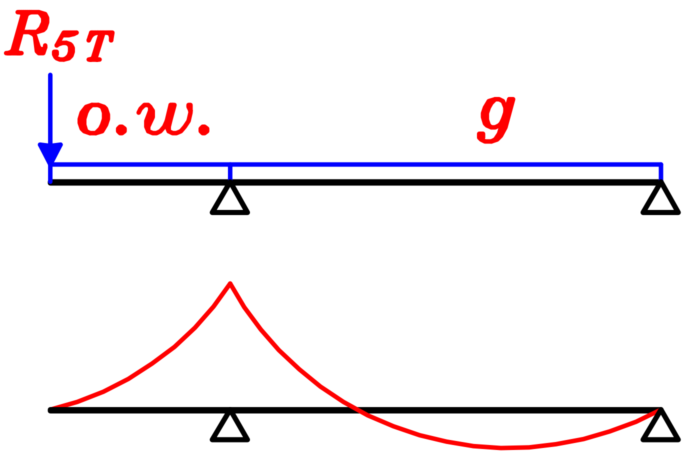
B_2

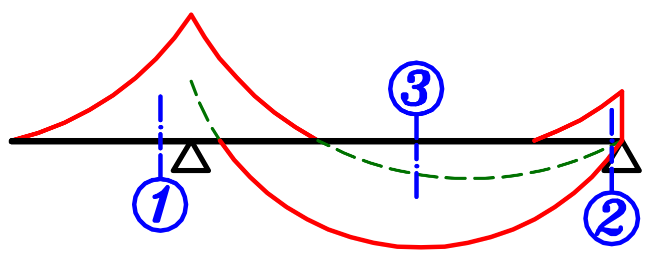


max. +Ve B.M.D.

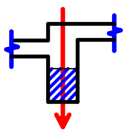


max. −Ve B.M.D.

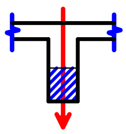




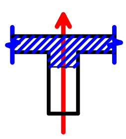
Sec. 1 R−Sec.



Sec. 2 R−Sec.



Sec. 3 T−Sec.

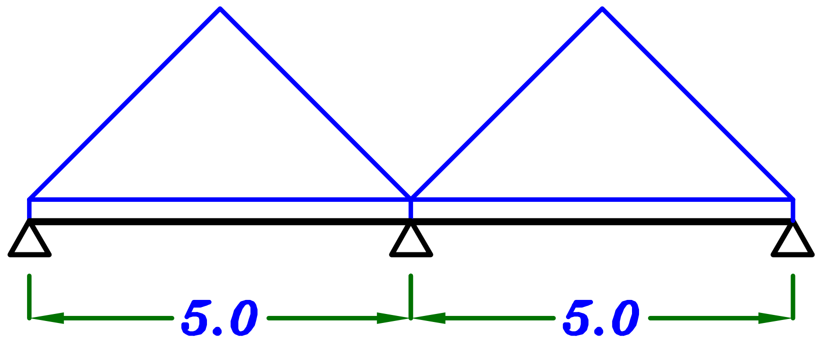


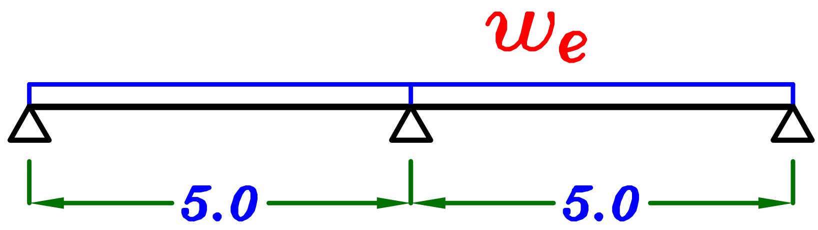
$K = 0.8$

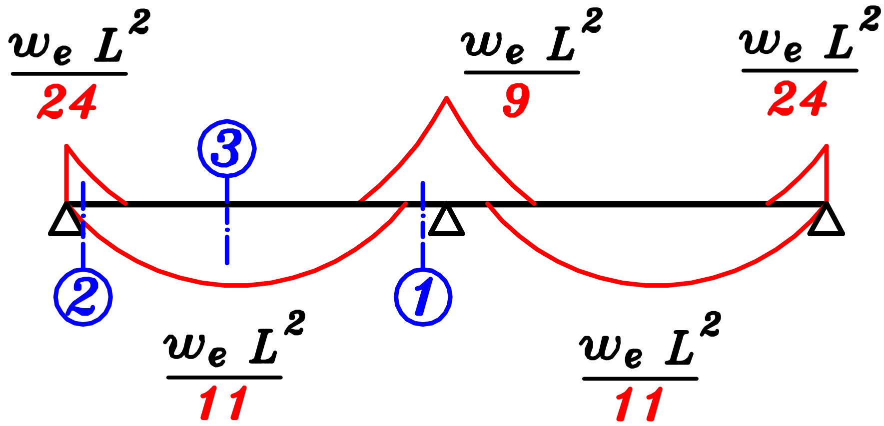
$\because M_T < 2\, M_R \quad \therefore$ Design R−Sec. at First.

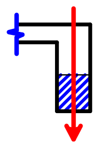
B_3

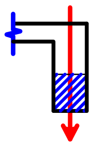
ملحوظه
لا نعمل حالات تحميل للكمرات المستمره لاننا نحفظ قيم
max–max B.M.D.

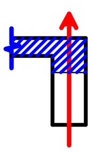






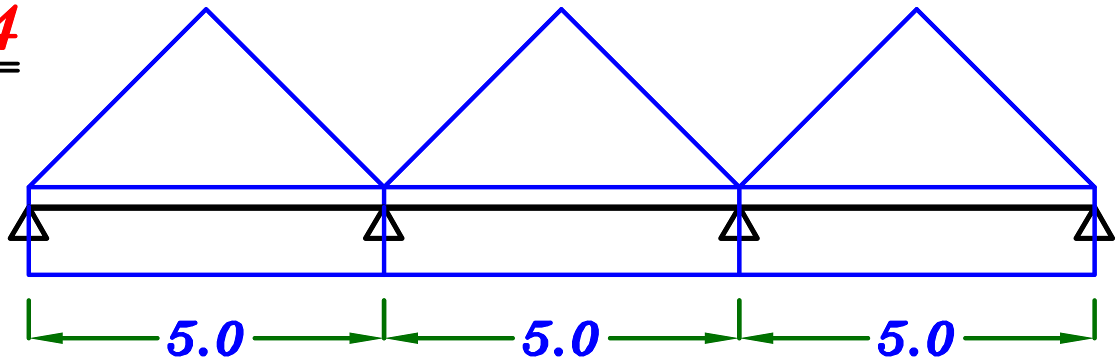
Sec. ① R–Sec. 

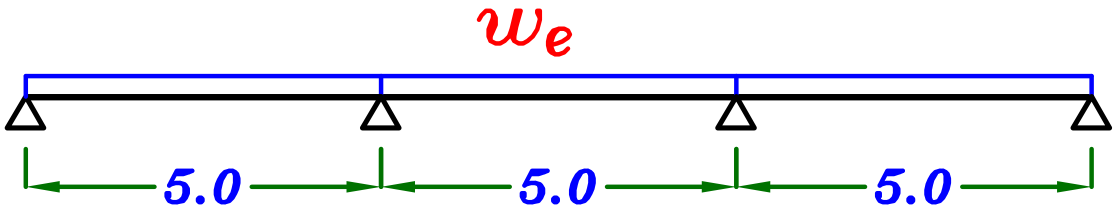
Sec. ② R–Sec. 

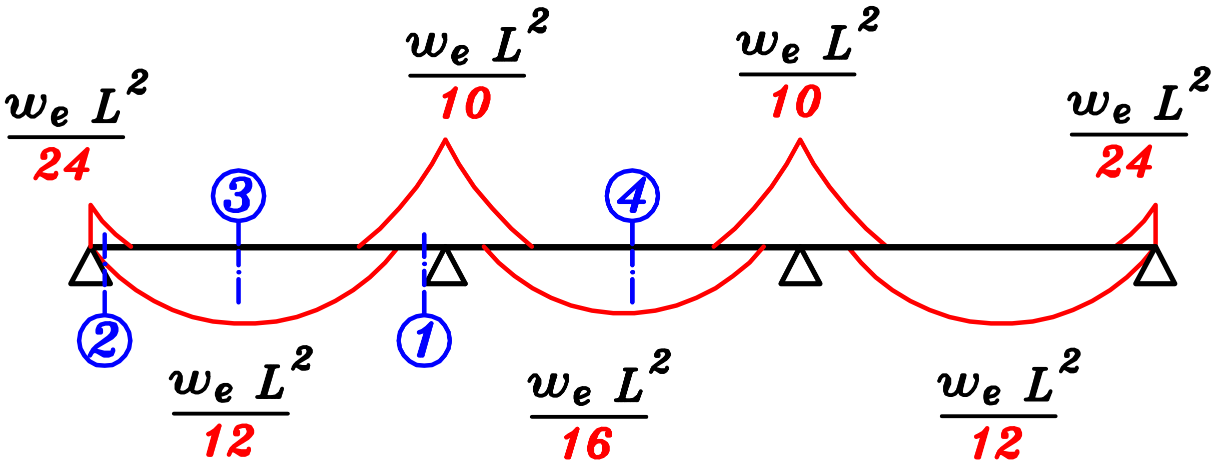
Sec. ③ L–Sec.  $K = 0.8$

$\because M_L < 2\, M_R \quad \therefore$ Design R–Sec. at First.

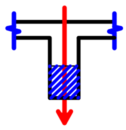
$\underline{\underline{B_4}}$

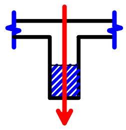


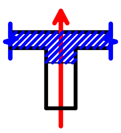


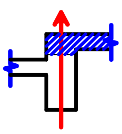


ملحوظه لا نعمل حالات تحميل للكمرات المستمره لاننا نحفظ قيم *max-max B.M.D.*

Sec. 1 R-Sec. 

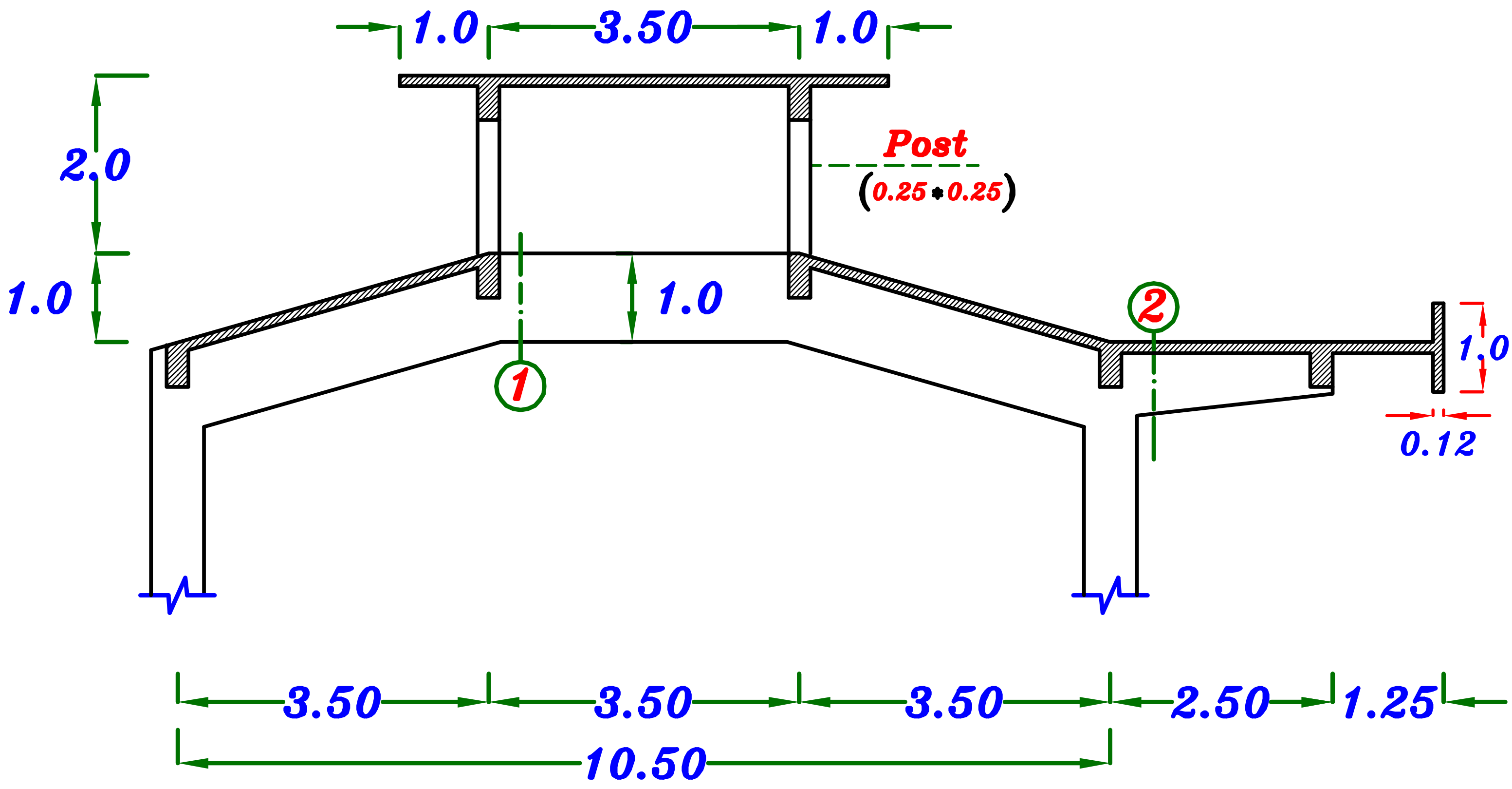
Sec. 2 R-Sec. 

Sec. 3 T-Sec.  $K = 0.8$

Sec. 4 L-Sec.  $K = 0.7$

$\because M_T < 2\,M_R \quad \therefore$ Design R-Sec. at First.

Example.



Data.

$t_s = 0.12\ m$, Spacing $= 6.0\ m$

O.W. of Girder $= 6.0\ kN\backslash m'$, O.W. of Beam $= 3.0\ kN\backslash m'$

$b_{(Beam)} = 250\ mm$, $b_{(Girder)} = 350\ mm$

L.L. $= 3.0\ kN\backslash m^2$, F.C. $= 1.5\ kN\backslash m^2$

$F_{cu} = 25\ N\backslash mm^2$, st. 360/520

Req.

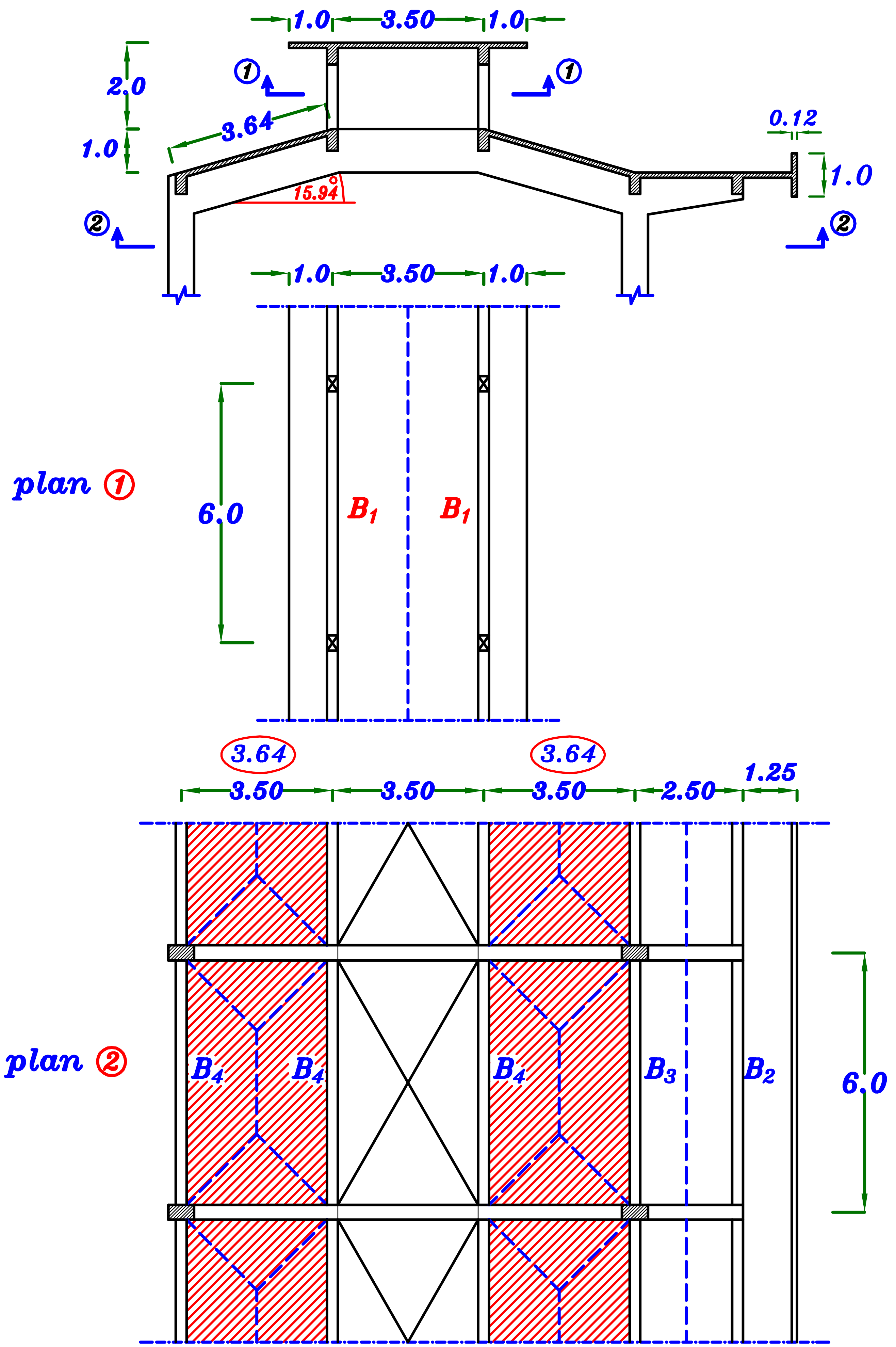
a- Calculate the equivalent working loads For shear and moment For the intermediate girder (G).

b- Draw the shearing Force diagram due to total Load and max-max bending moment diagram For an intermediate girder (G).

C- Design of the critical sections of the girder (G) to satisfy the bending requirements using the given dimensions (using U.L.D.M.)

d- Draw the details of reinforcement For girder (G) in elevation to Scale 1:25 and cross sections to Scale 1:10

a- Calculate the equivalent working loads For shear and moment For the intermediate girder (G).



g_s, p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \; kN\backslash m^2$

$p_{sh} = L.L. = 3.0 \; kN\backslash m^2$ ------ HL. Slab.

$p_{si} = L.L. * \cos\theta = 3.0 * \cos 15.94^\circ = 2.88 \; kN\backslash m^2$ --- Inclined Slab.

$\boxed{g_s = 4.50 \; kN\backslash m^2}$, $\boxed{p_{sh} = 3.0 \; kN\backslash m^2}$, $\boxed{p_{si} = 2.88 \; kN\backslash m^2}$

B_1

Load For Shear.

$$g_a = O.W. + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + (4.50)\left(\frac{3.5}{2}\right) + (4.50)(1.0) = 15.37 \; kN\backslash m'$$

$$p_a = p_{sh} \frac{L_s}{2} + p_{sh} L_c$$

$$= (3.0)\left(\frac{3.5}{2}\right) + (3.0)(1.0) = 8.25 \; kN\backslash m'$$

$$w_a = g_a + p_a = 15.37 + 8.25 = 23.62 \; kN\backslash m'$$

$R_1 = g_a * \text{Spacing} = 15.37 * 6.0 = 92.22 \; kN$ ----- D.L.

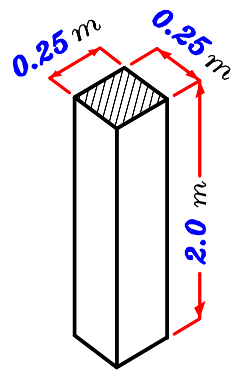
$= w_a * \text{Spacing} = 23.62 * 6.0 = 141.72 \; kN$ ----- T.L.

$$\boxed{\begin{aligned} R_1 &= 92.22 \; kN \text{ ---- D.L.} \\ &= 141.72 \; kN \text{ ---- T.L.} \end{aligned}}$$

Post

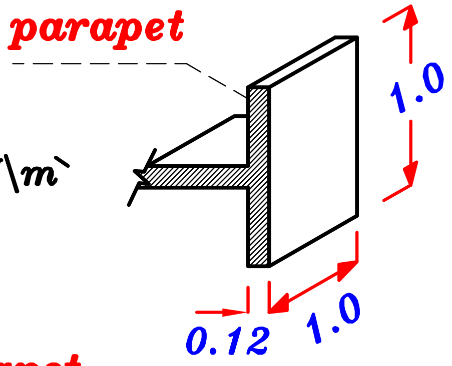
Weight of the Post = Volume * Density

$= (0.25 * 0.25 * 2.0)(25) = 3.12 \; kN$



$\boxed{\text{Weight of the Post} = 3.12 \; kN}$

B_2



$O.W.$ of parapet $= (0.12)(1.0)(1.0)(25) = 3.0$ kN\m`

Load For Shear.

$$g_a = O.W. + g_s \frac{L_s}{2} + g_s L_c + O.W. \text{ of parapet}$$

$$= 3.0 + (4.50)\left(\frac{2.5}{2}\right) + (4.50)(1.25) + 3.0 = 17.25 \text{ kN\m`}$$

$$p_a = p_{sh} \frac{L_s}{2} + p_{sh} L_c$$

$$= (3.0)\left(\frac{2.5}{2}\right) + (3.0)(1.25) = 7.5 \text{ kN\m`}$$

$$w_a = g_a + p_a = 17.25 + 7.5 = 24.75 \text{ kN\m`}$$

$R_2 = g_a * \text{Spacing} = 17.25 * 6.0 = 103.5$ kN ------ D.L.

$= w_a * \text{Spacing} = 24.75 * 6.0 = 148.5$ kN ------ T.L.

$R_2 = 103.5$ kN ----- D.L.

$= 148.5$ kN ---- T.L.

B_4 Load For Shear.

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.64}{6.0}\right) = 0.696$

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} = 3.0 + (0.696)(4.50)\left(\frac{3.64}{2}\right) = 8.70 \text{ kN\m`}$$

$$p_a = C_a\, p_{si} \frac{L_s}{2} = (0.696)(2.88)\left(\frac{3.64}{2}\right) = 3.648 \text{ kN\m`}$$

$$w_a = g_a + p_a = 8.70 + 3.648 = 12.35 \text{ kN\m`}$$

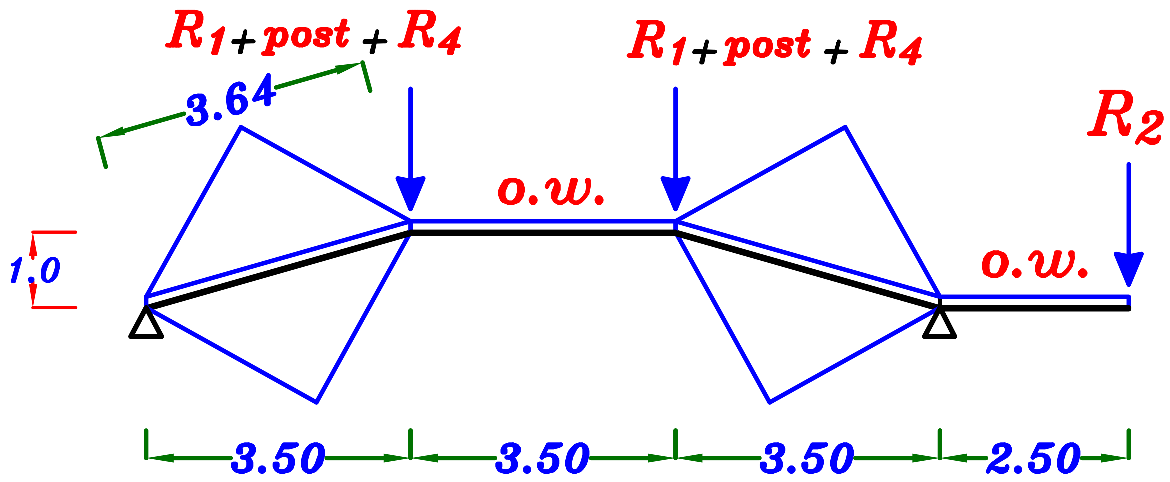
$R_4 = g_a * \text{Spacing} = 8.70 * 6.0 = 52.2$ kN ------ D.L.

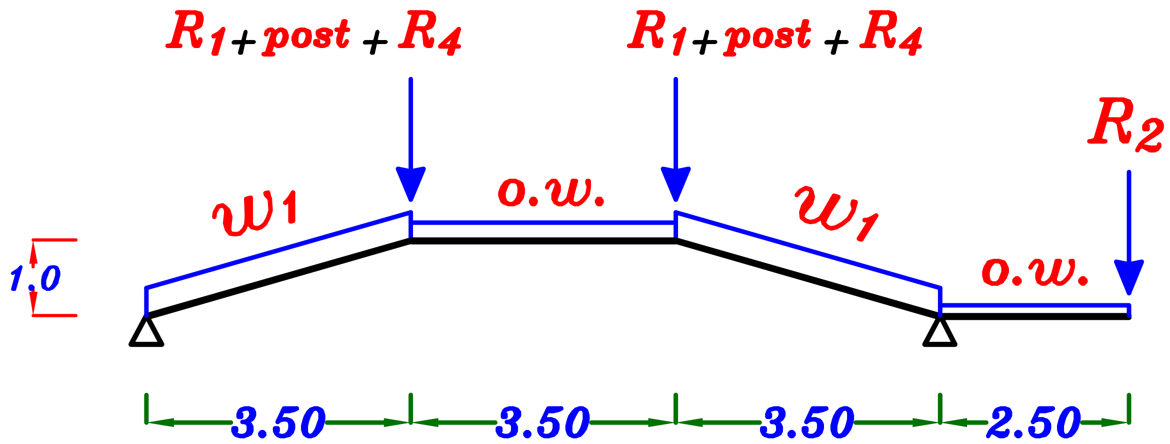
$= w_a * \text{Spacing} = 12.35 * 6.0 = 74.10$ kN ------ T.L.

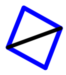
$R_4 = 52.2$ kN ----- D.L.

$= 74.10$ kN ---- T.L.

Load on the Girder.







$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3.64)\left(\frac{3.64}{2}\right)\right)}{3.64} = 1.82$$

$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s$$

$$= 6.0 + 1.82 \quad (4.50) = 14.19 \ kN\backslash m`$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_{si}$$

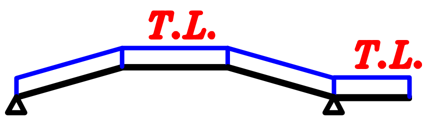
$$= 1.82 \ (2.88) = 5.24 \ kN\backslash m`$$

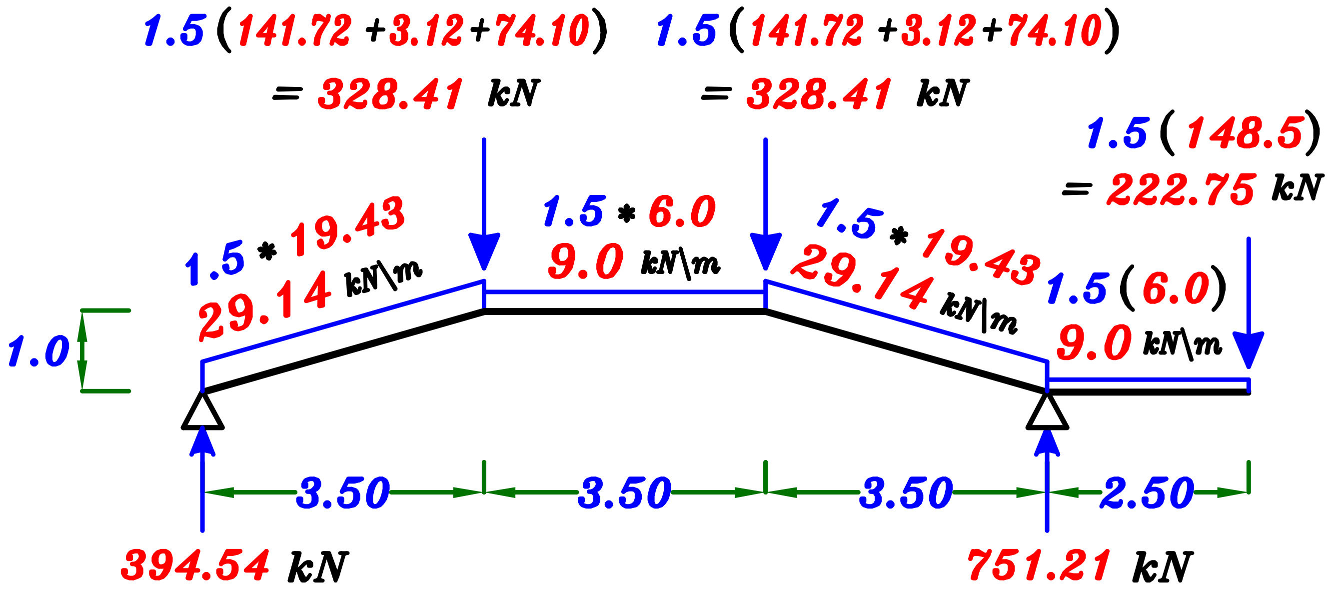
$$w_1 = w_a = w_e = g_1 + p_1 = 14.19 + 5.24 = 19.43 \ kN\backslash m`$$

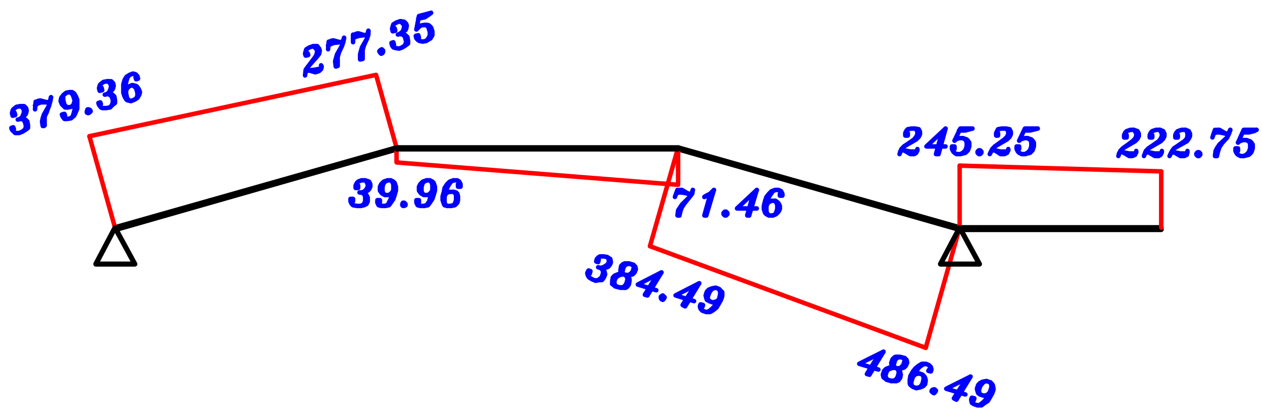
$g_1 = 14.19 \ kN\backslash m`$ --- D.L.
$w_1 = 19.43 \ kN\backslash m`$ --- T.L.

b - Draw the shearing Force diagram due to total Load and max–max bending moment diagram For an intermediate girder (G).

S.F.D. For the Girder. U.L.

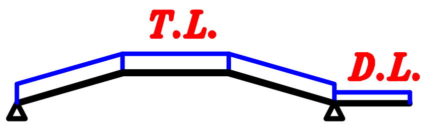


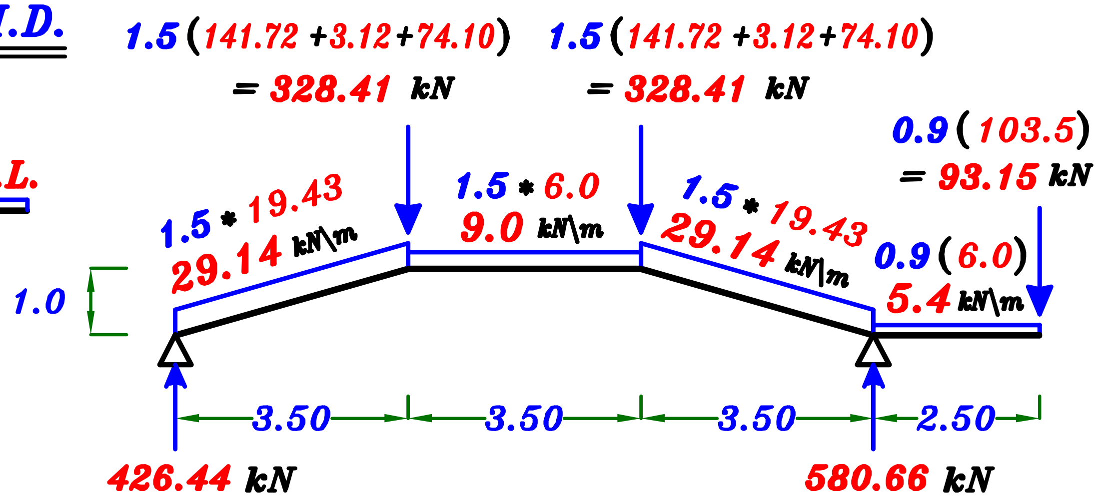


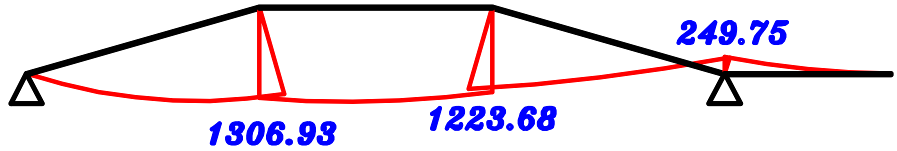


max–max B.M.D. For the Girder. U.L.

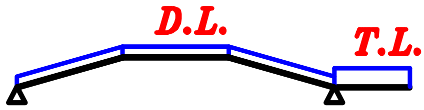
1- max. +Ve B.M.D.

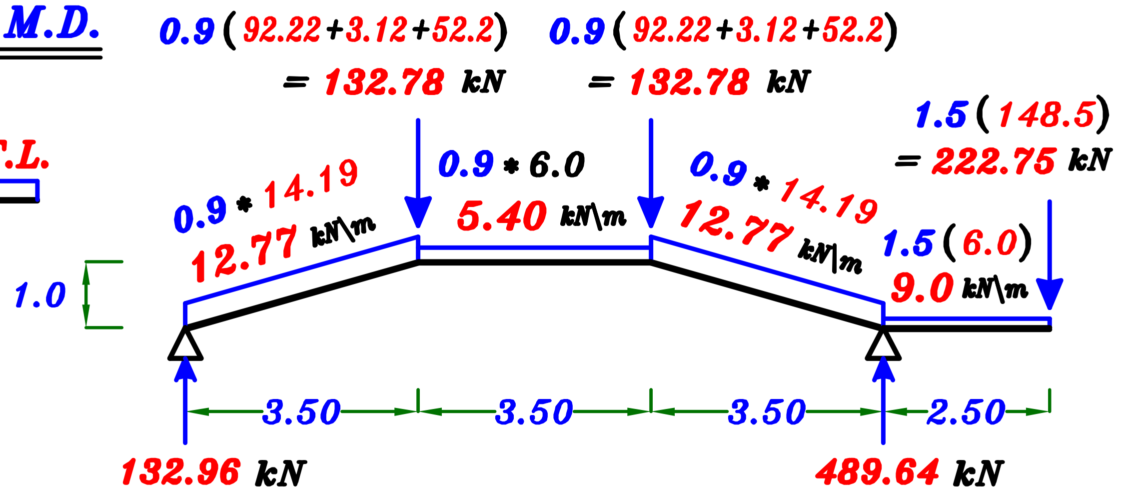


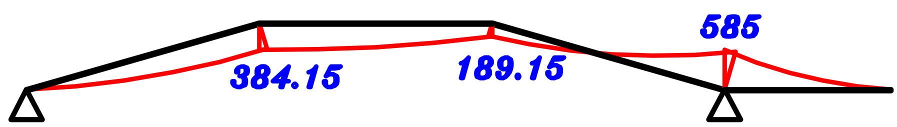




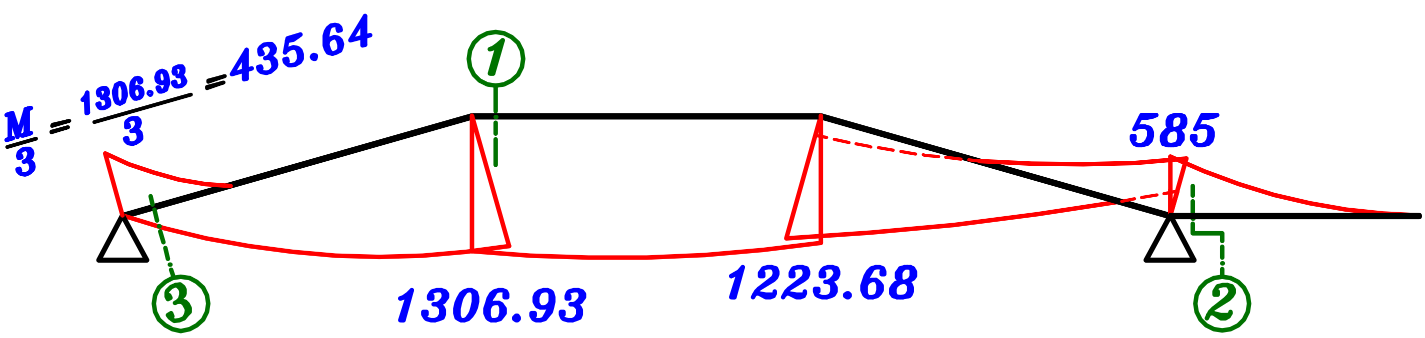
2- max. –Ve B.M.D.



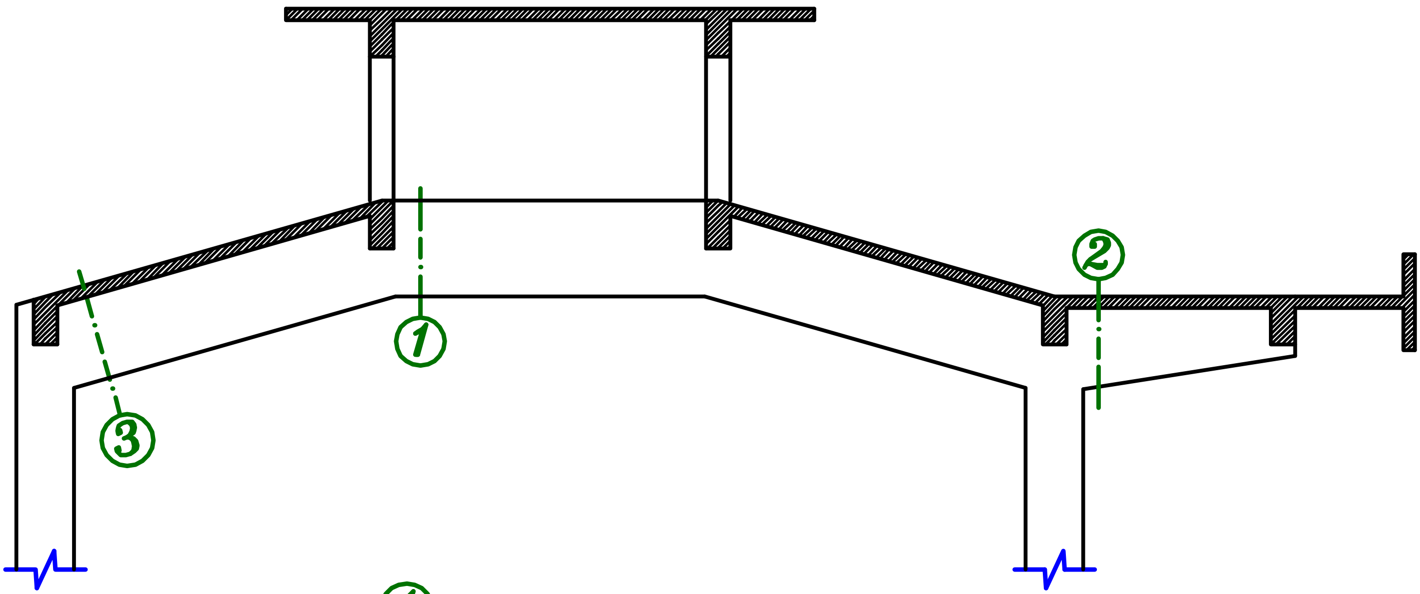


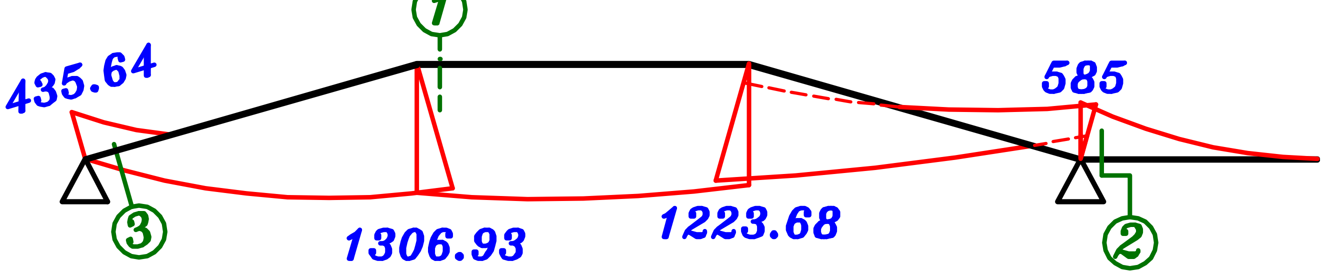


max–max B.M.D. For the Girder.

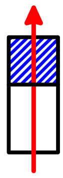


C_ Design of the critical sections of the girder (G) to satisfy the bending and shear requirements using the given dimensions (using U.L.D.M.)





Sec. 1 $M_{U.L.} = 1306.93$ kN.m $b = 350$ mm R−Sec.



Take $d = 0.95$ m (as given in Data.)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 950 = C_1 \sqrt{\frac{1306.93 * 10^6}{25 * 350}} \longrightarrow C_1 = 2.45 < 2.78$$

$\therefore$ We need to use $A_{s`}$

$$a_{max} = 0.8\left(\frac{2}{3}\right)\left[\frac{600}{600 + (F_y \backslash \gamma_s)}\right] * d = 0.35\, d = 0.35 * 950 = 332 \text{ mm}$$

$$M_{U.L._{max}} = \frac{2}{3}\frac{F_{cu}}{\gamma_c}\, a_{max}\, b\left(d - \frac{a_{max}}{2}\right) = \frac{2}{3}\left(\frac{25}{1.5}\right)(332)(350)\left(950 - \frac{332}{2}\right) = 1012231111 \text{ N.mm}$$

$$= 1012.2 \text{ kN.m}$$

– Get $\Delta M = M_{U.L.} - M_{U.L._{max.}} = 1306.93 - 1012.2 = 294.73$ kN.m

– Get $A_{s`}$ From $\Delta M = A_{s`} \frac{F_y}{\gamma_s}(d - d`)$

$$\therefore 294.73 * 10^6 = A_{s`}\left(\frac{360}{1.15}\right)(950 - 50) \longrightarrow A_{s`} = 1046.1 \text{ mm}^2$$

5 ϕ 18

$\mu_{max.} = 5*10^{-4} F_{cu} = 5*10^{-4}*25 = 0.0125$ From Code Page (4-6) Table (4-1)

$\therefore A_s = \mu_{max.} b\, d + A_s' = (0.0125)(350)(950) + 1046.1 = 5202.35\ mm^2$

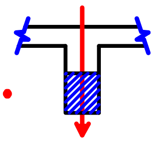
11 ϕ 25

$-$ Check $\frac{A_s'}{A_s} = \frac{1046.1}{5202.35} = 0.201 < 0.40 \quad \therefore$ o.k.

$\therefore\ n = \frac{b-25}{\phi+25} = \frac{350-25}{22+25} = 6.5 = 6.0$ bars

Sec. ②

$M_{U.L.} = 585$ kN.m , $b = 350$ mm R-Sec.



Take $d = 0.95$ m (as given in Data.)

$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore\ 950 = C_1 \sqrt{\frac{585*10^6}{25*350}} \longrightarrow C_1 = 3.67 \longrightarrow J = 0.789$

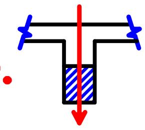
$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{585*10^6}{0.789*360*950} = 2167.9\ mm^2$

$-$ Check $A_{s_{min.}}$ $\quad A_{s_{req.}} = 2167.9\ mm^2$

$\mu_{min.} b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 950 = 1039\ mm^2$

$\therefore A_{s_{req.}} > \mu_{min.} b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 2167.9\ mm^2$ 6 ϕ 22

Sec. ③

$M_{U.L.} = 435.64$ kN.m , $b = 350$ mm , R–Sec. 

Take $d = 0.95$ m (as given in Data.)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 950 = C_1 \sqrt{\frac{435.64 * 10^6}{25 * 350}} \longrightarrow C_1 = 4.25 \longrightarrow J = 0.811$$

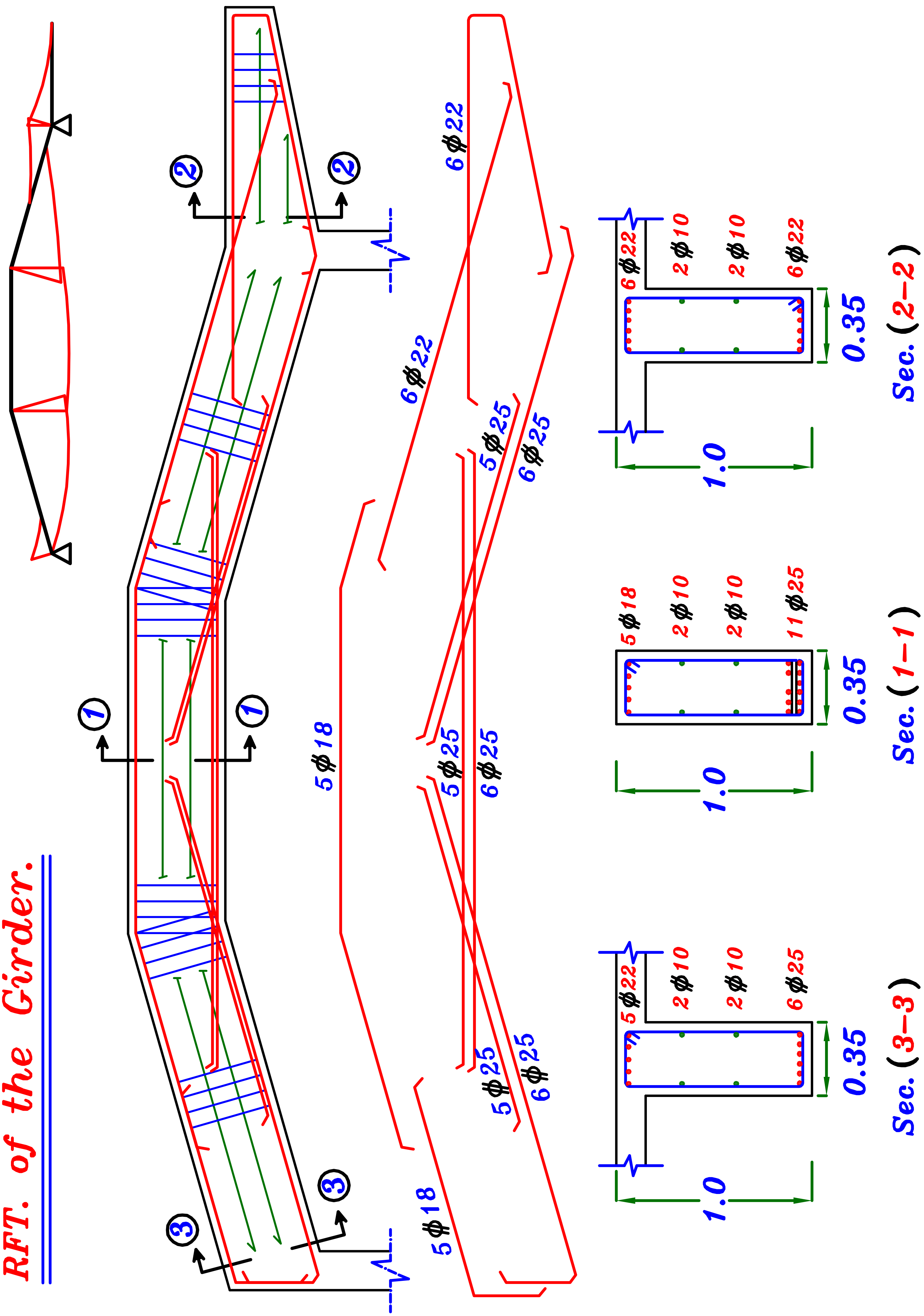
$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{435.64 * 10^6}{0.811 * 360 * 950} = 1570.65 \text{ mm}^2$$

– Check $A_{s_{min.}}$ $\quad A_{s_{req.}} = 1570.65 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 950 = 1039 \text{ mm}^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 1570.65 \text{mm}^2 \quad 5\phi 22$$

RFT. of the Girder.



Example.

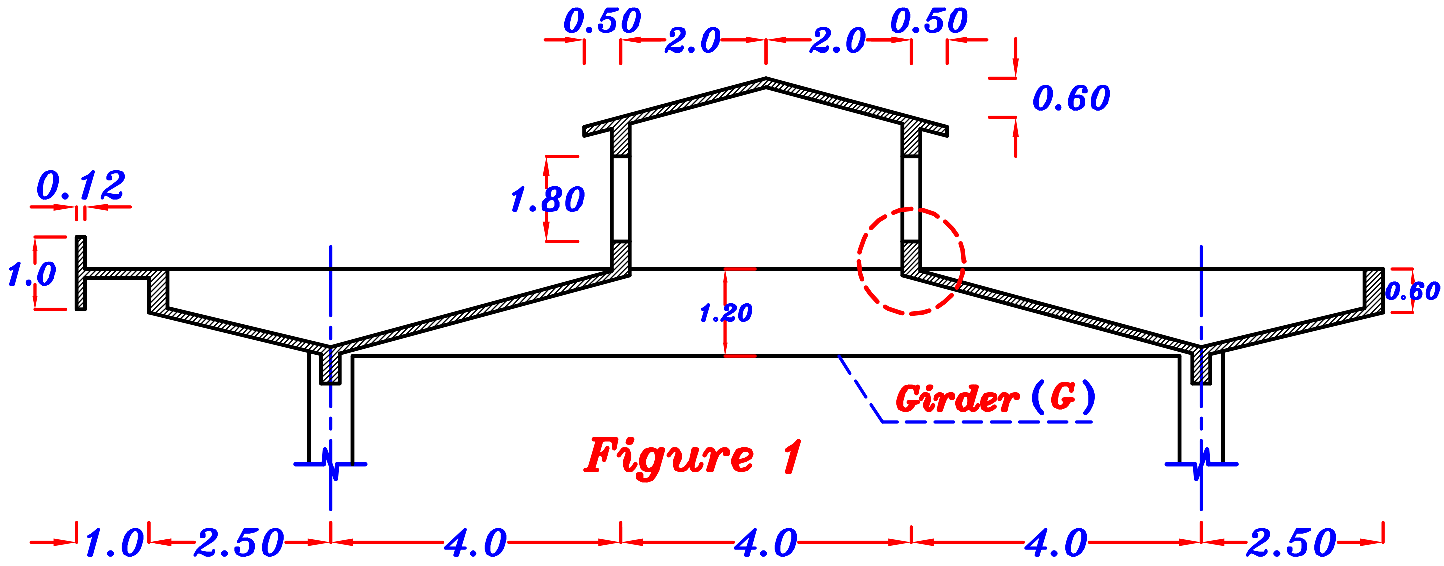


Figure 1

Figure 1 shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams. and Girders (G), spaced at 6.0 m .

$F_{cu} = 25$ N\mm^2 st. 360/520

It is required:

1- Draw a structural plan showing the pattern of load distribution.

2- Calculate the equivalent working loads for shear and moment For an intermediate Girder (G).

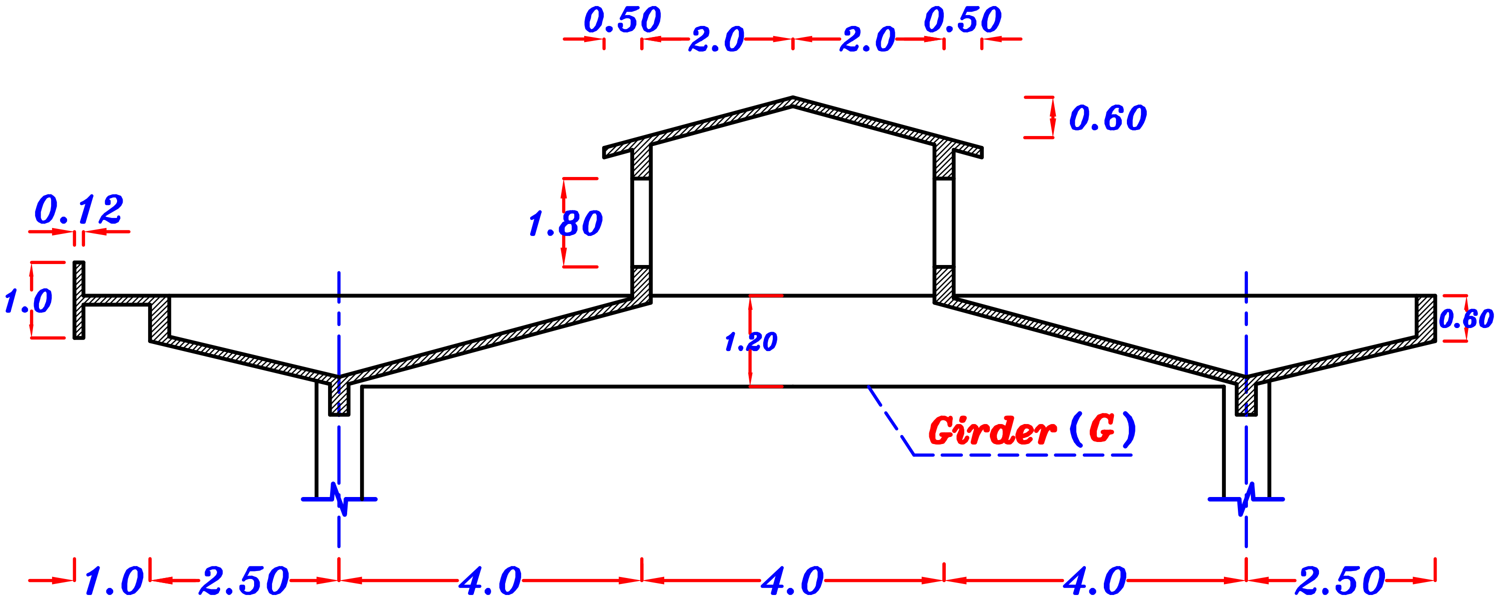
3- Draw the S.F.D. (total loads) and max.–max. B.M.D. For an intermediate Girder (G). using ultimate limit loads.

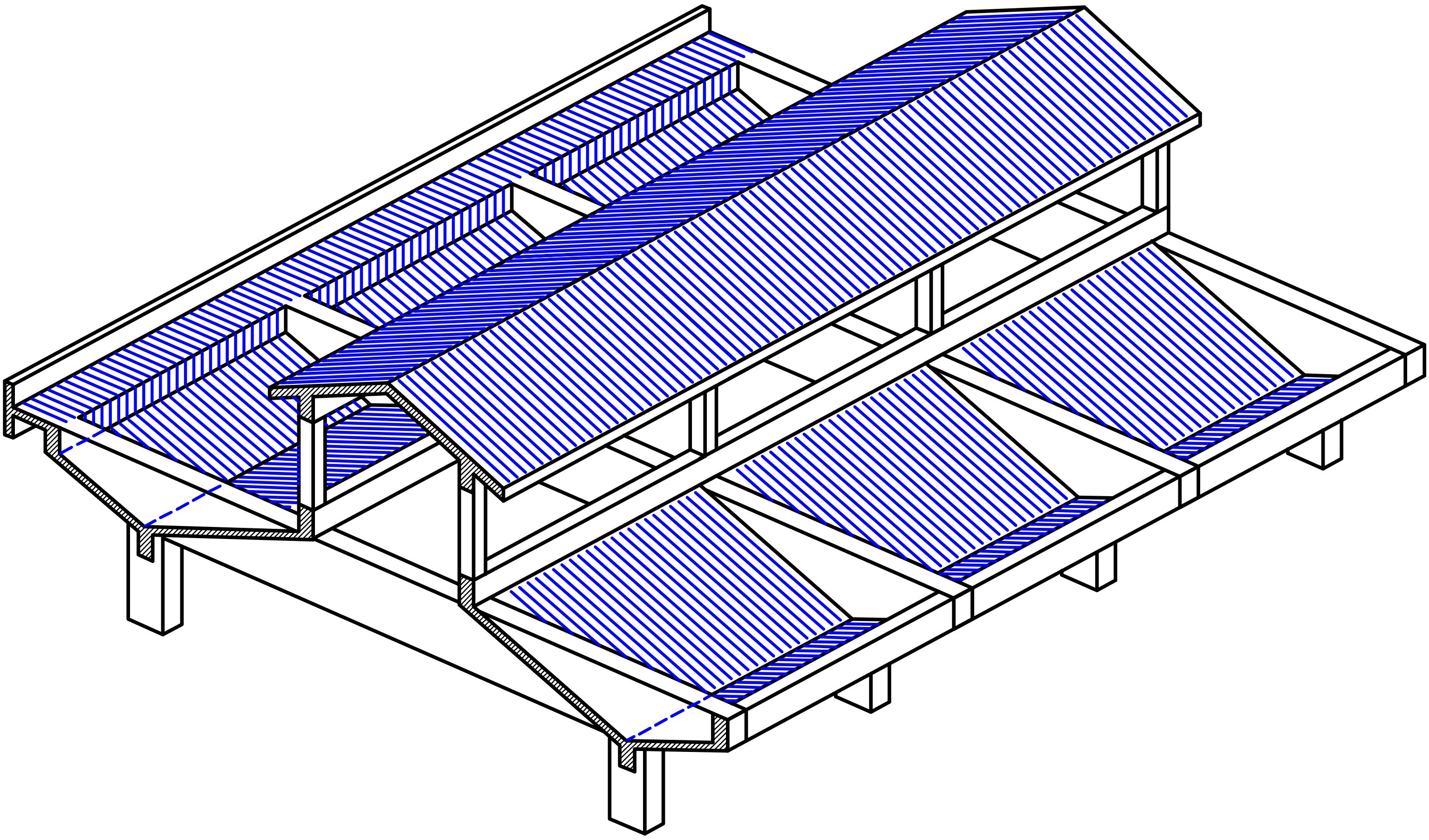
4- Design an intermediate Girder (G) using charts and draw its details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

5- Design the marked beam using charts and draw its details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

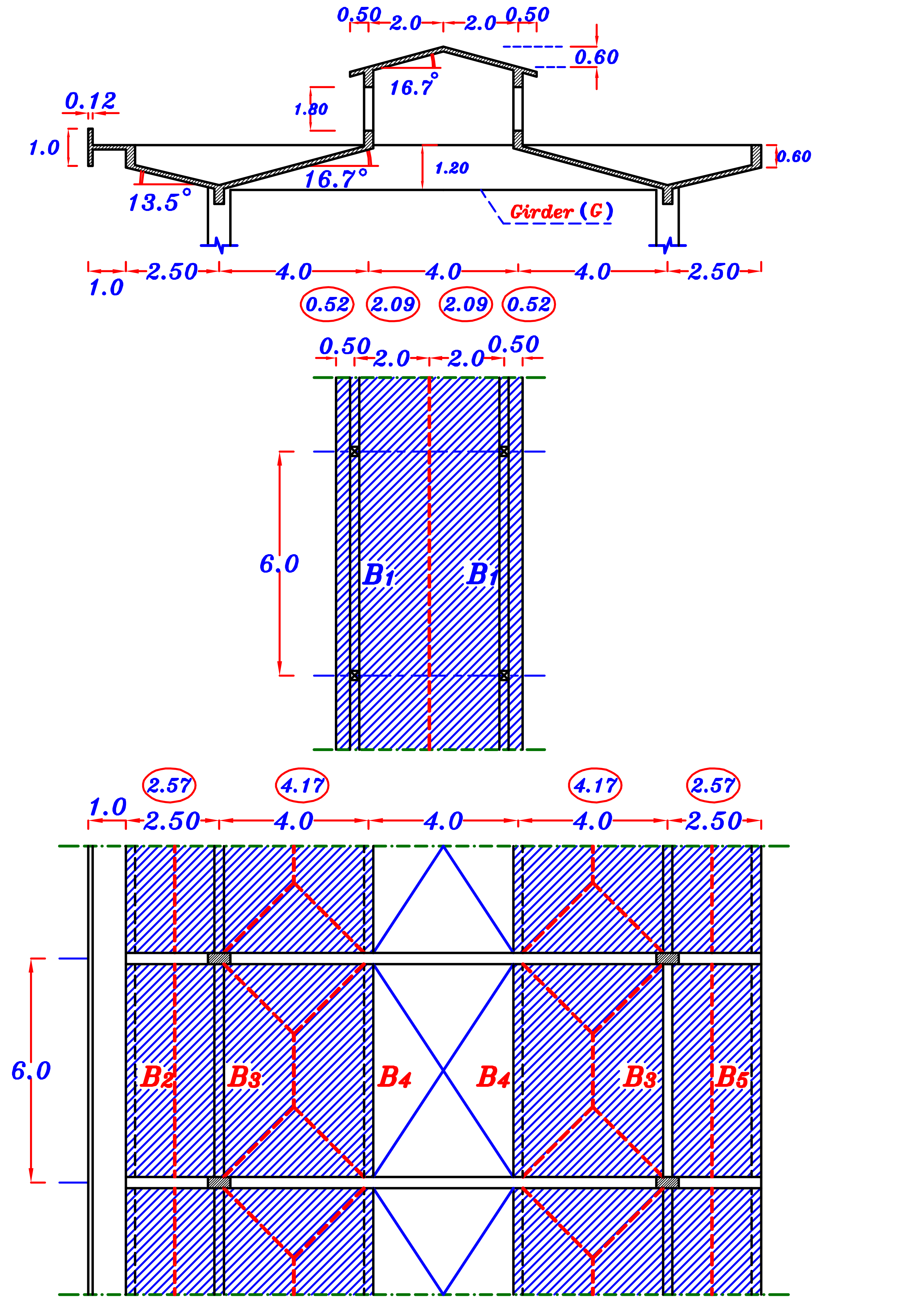
Data:

- Slab thickness $t_s = 120$ mm
- Live load = 1.0 kN\m^2
- Floor cover = 1.5 kN\m^2
- Breadth of all beams = 250 mm
- Breadth of all girders = 300 mm
- Own weight of beams = 3.0 kN\m
- Own weight of girders = 6.0 kN\m





ملحوظه هامه . البلاطه مائله لكن ال Girder أفقى


0.50
2.0
2.0
0.50
0.60
16.7°
1.80
0.12
1.0
16.7°
1.20
0.60
13.5°
Girder (G)
1.0
2.50
4.0
4.0
4.0
2.50
0.52
2.09
2.09
0.52
0.50
2.0
2.0
0.50
6.0
B1
B1
2.57
4.17
4.17
2.57
1.0
2.50
4.0
4.0
4.0
2.50
6.0
B2
B3
B4
B4
B3
B5

g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50\ kN\backslash m^2$

$p_{sh} = L.L. = 1.0\ kN\backslash m^2$ ------ HL. Slab.

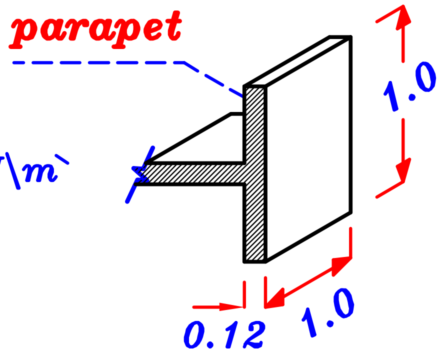
$p_{si1} = L.L. * \cos\theta = 1.0 * \cos 16.7^\circ = 0.957\ kN\backslash m^2$ --- For Inclination 16.7°

$p_{si2} = L.L. * \cos\theta = 1.0 * \cos 13.5^\circ = 0.972\ kN\backslash m^2$ --- For Inclination 13.5°

$\boxed{g_s = 4.50\ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0\ kN\backslash m^2}$

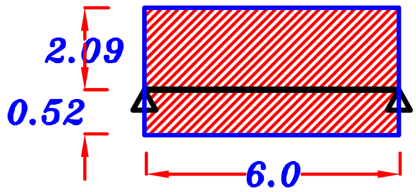
$\boxed{p_{si1} = 0.957\ kN\backslash m^2}$, $\boxed{p_{si2} = 0.972\ kN\backslash m^2}$

O.W. of parapet



O.W. of parapet $= (0.12)(1.0)(1.0)(25) = 3.0\ kN\backslash m'$

B_1 Load For Shear.



$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c$

$= 3.0 + (4.50)(2.09) + (4.50)(0.52) = 14.74\ kN\backslash m'$

$p_a = p_{si1} \frac{L_s}{2} + p_{si1} L_c$

$= (0.957)(2.09) + (0.957)(0.52) = 2.49\ kN\backslash m'$

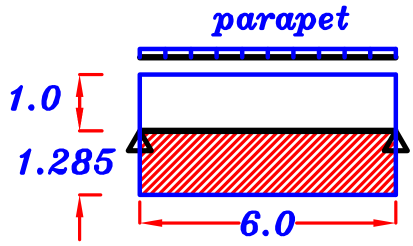
$w_a = g_a + p_a = 14.74 + 2.49 = 17.23\ kN\backslash m'$

$R_1 = g_a * Spacing = 14.74 * 6.0 = 88.44\ kN$ ------ D.L.

$= w_a * Spacing = 17.23 * 6.0 = 103.38\ kN$ ------ T.L.

$$\boxed{\begin{array}{l} R_1 = 88.44\ kN \text{ ------ D.L.} \\ \quad = 103.38\ kN \text{ ------ T.L.} \end{array}}$$

B_2 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c + parapet$$

$$= 3.0 + (4.50)\left(\frac{2.57}{2}\right) + (4.50)(1.0) + 3.0 = 16.28 \ kN\backslash m`$$

$$p_a = p_{si2} \frac{L_s}{2} + p_{sh} L_c$$

$$= (0.972)\left(\frac{2.57}{2}\right) + (1.0)(1.0) = 2.25 \ kN\backslash m`$$

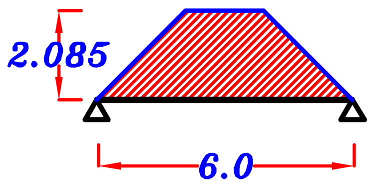
$$w_a = g_a + p_a = 16.28 + 2.25 = 18.53 \ kN\backslash m`$$

$$R_2 = g_a * Spacing = 16.28 * 6.0 = 97.68 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 18.53 * 6.0 = 111.18 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 97.68 \ kN \text{ ------ D.L.} \\ &= 111.18 \ kN \text{ ------ T.L.} \end{aligned}}$$

B_4 For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.17}{6}\right) = 0.652$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.17}{6}\right)^2 = 0.839$$

Load For Shear.

$$g_a = o.w. + C_a g_s \frac{L_s}{2} = 3.0 + (0.652)(4.50)\left(\frac{4.17}{2}\right) = 9.12 \ kN\backslash m`$$

$$p_a = C_a p_{si1} \frac{L_s}{2} = (0.652)(0.957)\left(\frac{4.17}{2}\right) = 1.30 \ kN\backslash m`$$

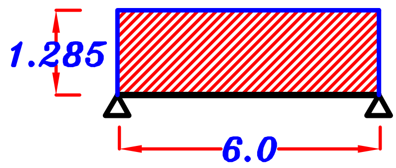
$$w_a = g_a + p_a = 9.12 + 1.30 = 10.42 \ kN\backslash m`$$

$$R_4 = g_a * Spacing = 9.12 * 6.0 = 54.72 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 10.42 * 6.0 = 62.52 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 54.72 \ kN \text{ ------ D.L.} \\ &= 62.52 \ kN \text{ ------ T.L.} \end{aligned}}$$

B_5 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} = 3.0 + (4.50)\left(\frac{2.57}{2}\right) = 8.78 \quad kN\backslash m'$$

$$p_a = p_{si2} \frac{L_s}{2} = (0.972)\left(\frac{2.57}{2}\right) = 1.25 \quad kN\backslash m'$$

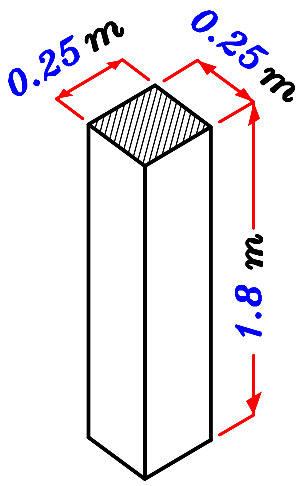
$$w_a = g_a + p_a = 8.78 + 1.25 = 10.03 \quad kN\backslash m'$$

$$R_5 = g_a * Spacing = 8.78 * 6.0 = 52.68 \quad kN \text{ ------ } D.L.$$

$$= w_a * Spacing = 10.03 * 6.0 = 60.18 \quad kN \text{ ------ } T.L.$$

$$\boxed{\begin{aligned} R_5 &= 52.68 \ kN \text{ ------ } D.L. \\ &= 60.18 \ kN \text{ ------ } T.L. \end{aligned}}$$

Post



Weight of the Post = Volume * Density

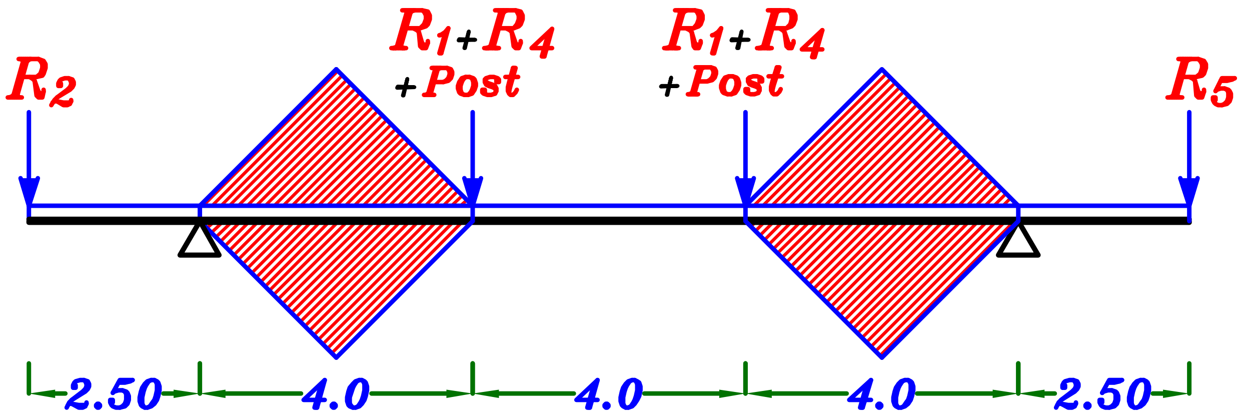
$$= (0.25 * 0.25 * 1.80)(25) = 2.81 \quad kN$$

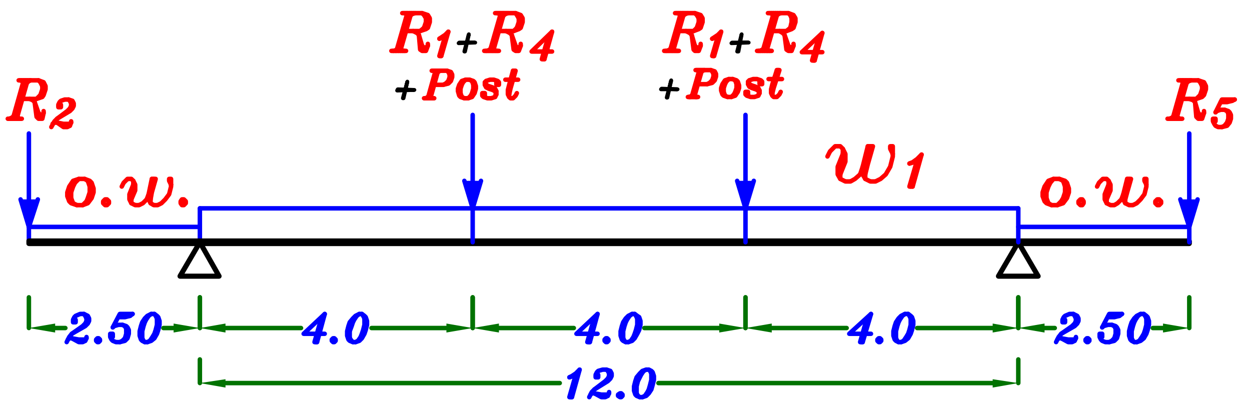
$$\boxed{\text{Weight of the Post} = 2.81 \ kN}$$

Note : Weight of Post can be neglected.

Loads on the Girder.

ملحوظه هامه . البلاطه مائله لكن ال Girder أفقى





$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}(4.17)\left(\frac{4.17}{2}\right)\right)}{12.0} = 1.45$$

$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s$$

$$= 6.0 + 1.45\ (4.50) = 12.52\ kN\backslash m$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_{si1}$$

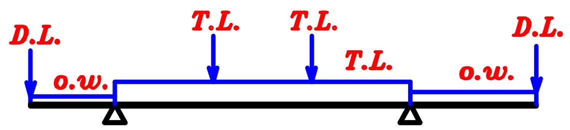
$$= 1.45\ (0.957) = 1.387\ kN\backslash m`$$

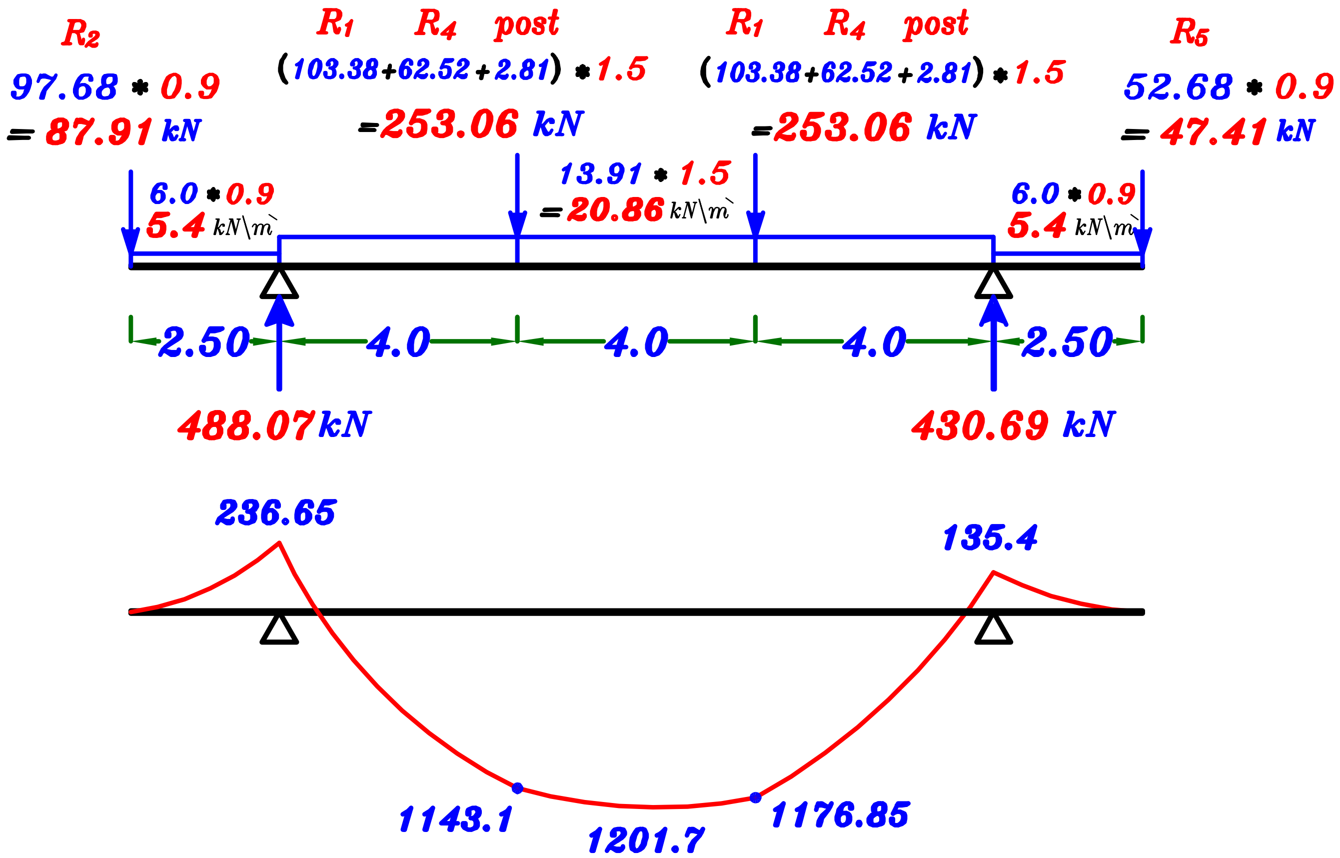
$$w_1 = w_a = w_e = g_1 + p_1 = 12.52 + 1.387 = 13.91\ kN\backslash m`$$

$$g_1 = 12.52\ kN\backslash m` \text{ ---- D.L.}$$
$$w_1 = 13.91\ kN\backslash m` \text{ ---- T.L.}$$

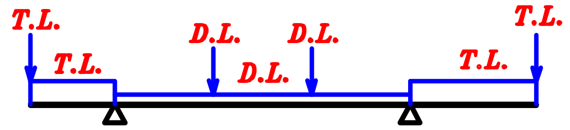
max-max U.L. B.M.D. For the Girder.

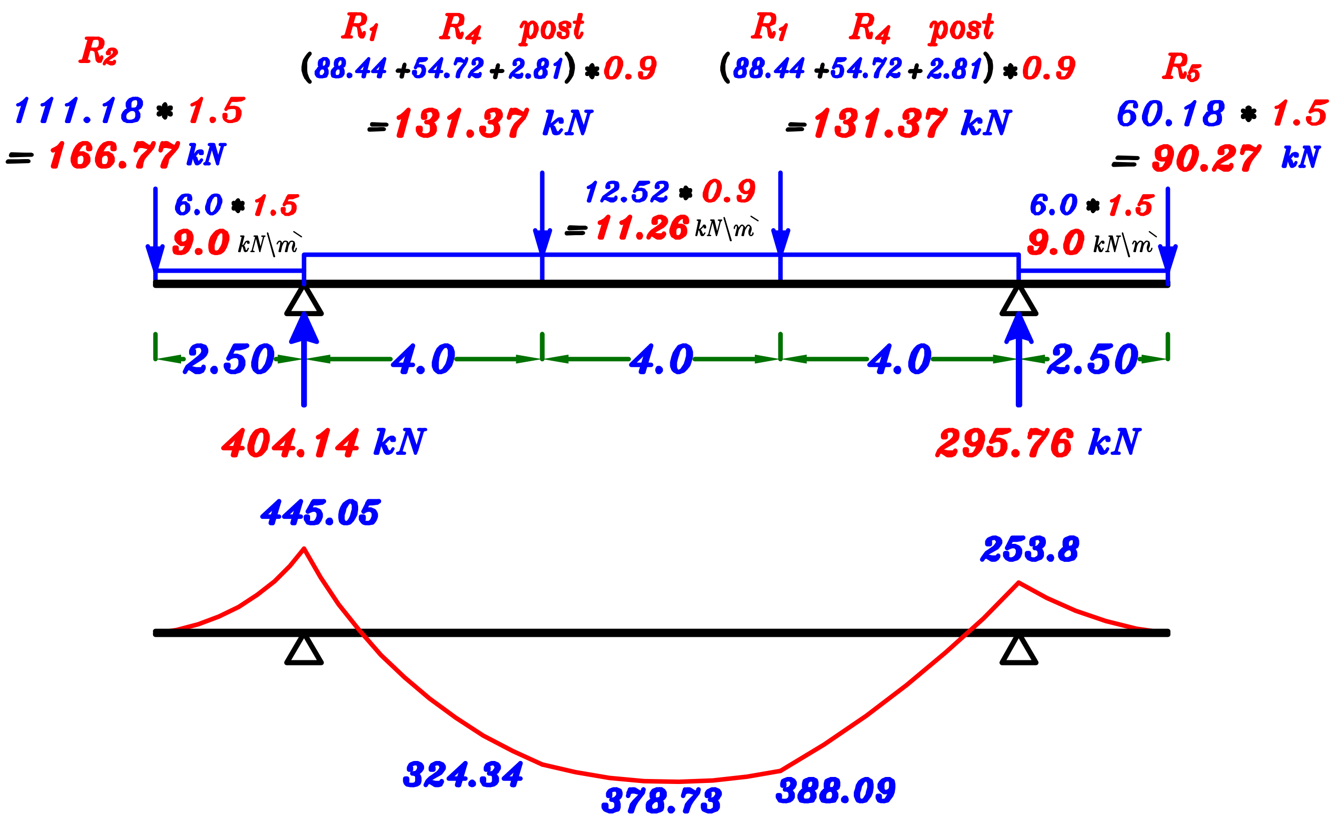
1- max. +ve B.M.D.



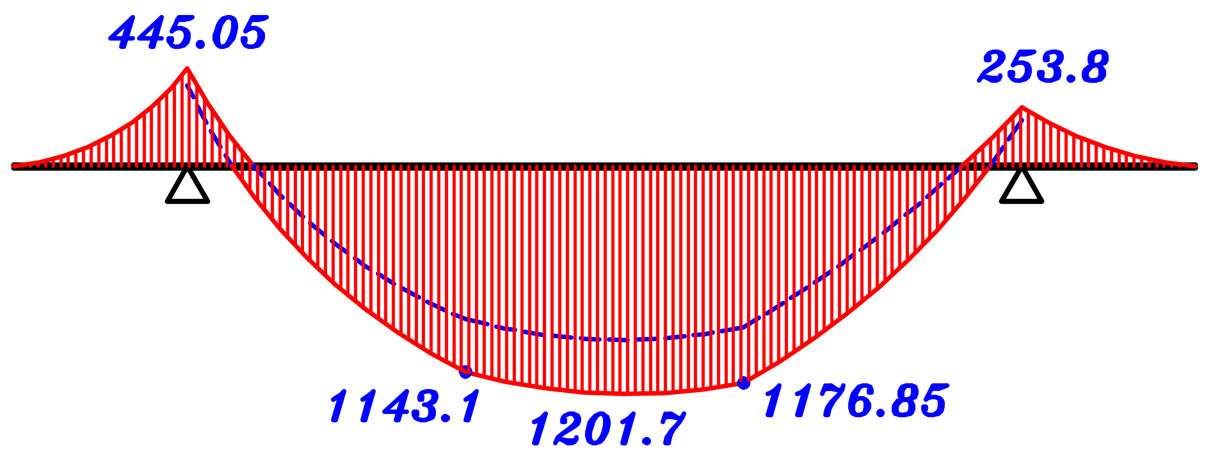


2- max. -ve B.M.D.

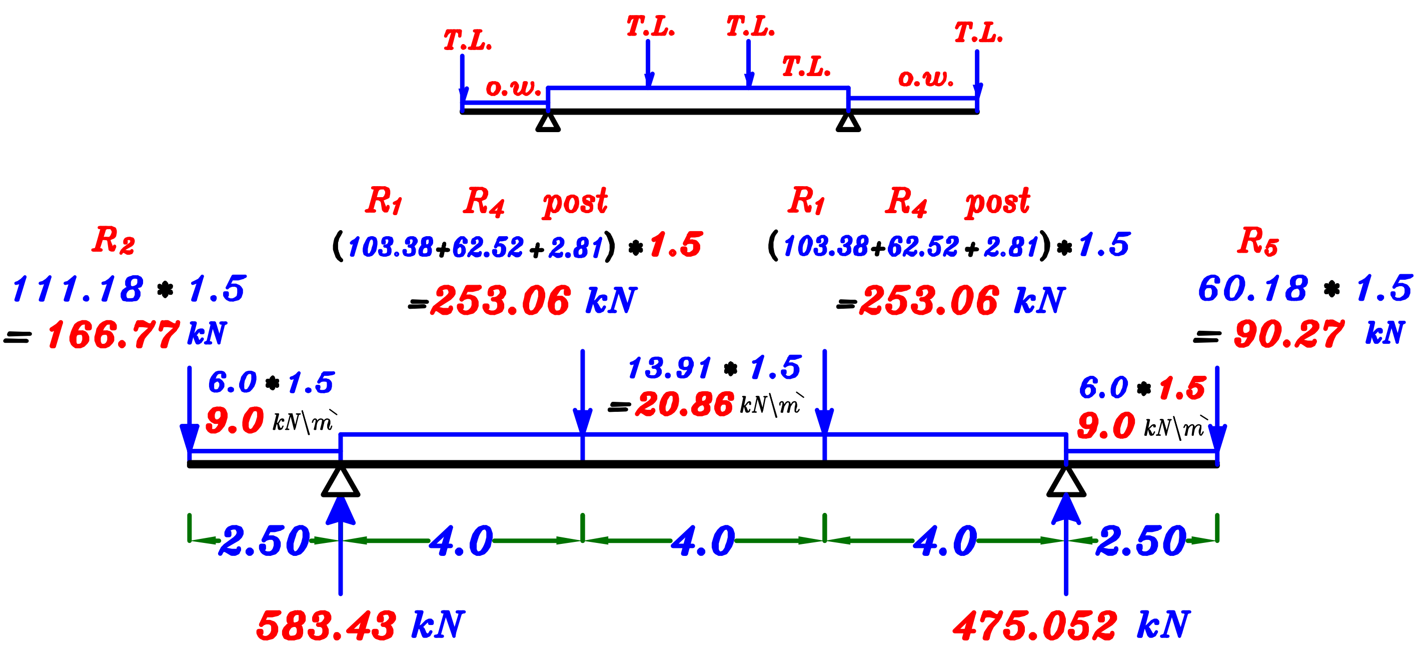


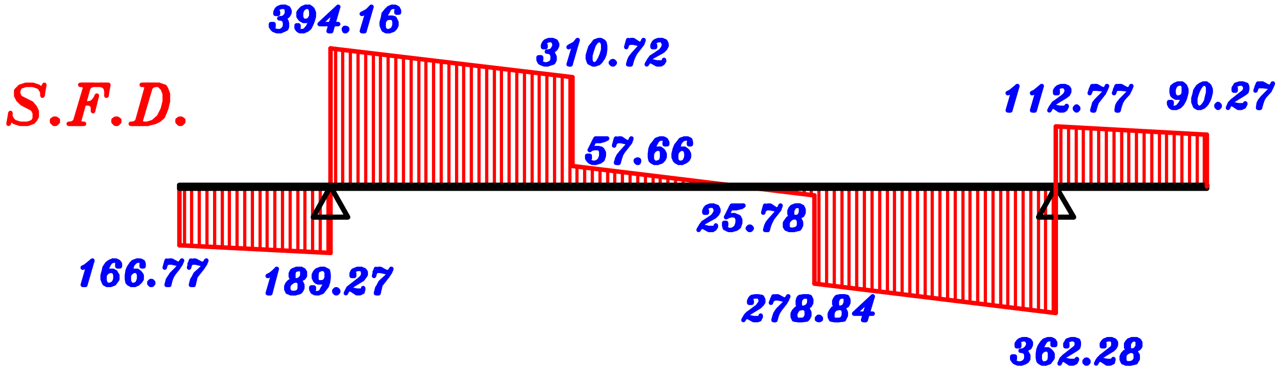


max-max B.M.D. For the Girder.

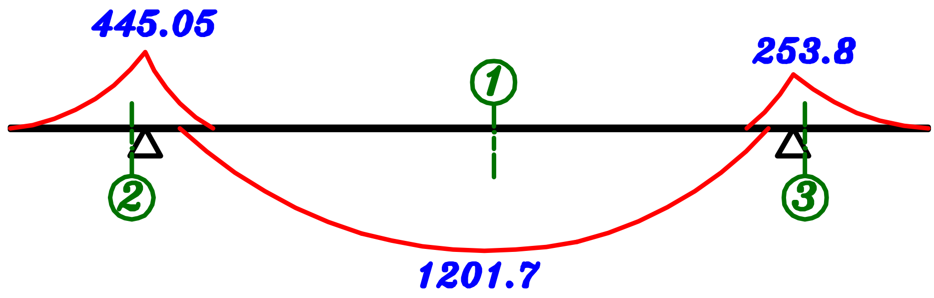


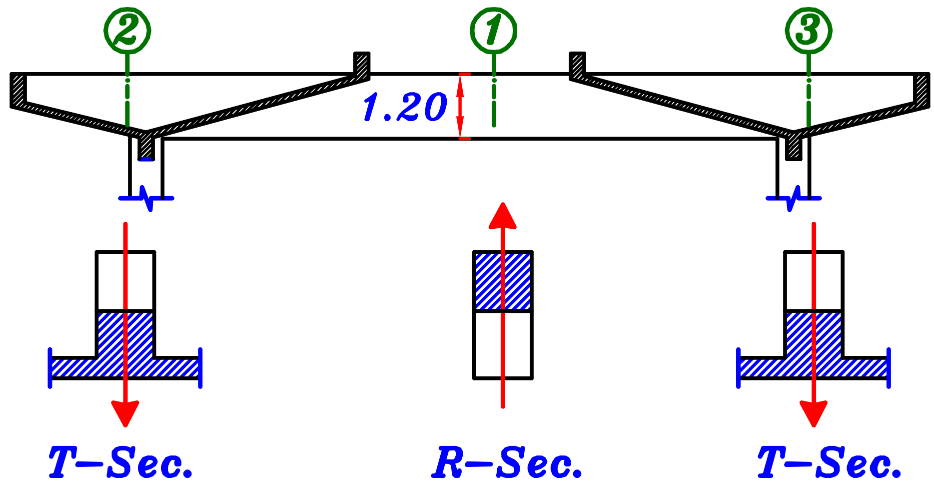
S.F.D. For the Girder.





4- Design an intermediate Girder (G) using charts and draw its details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

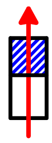




$\because M_T < 2\, M_R \quad \therefore$ **Design R-Sec. at First.**

Sec. 1

$M_{U.L.} = 1201.7$ kN.m



R-Sec. $\quad b = 300$ mm

Take $d = 1150$ mm (as given in data)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 1150 = C_1 \sqrt{\frac{1201.7 * 10^6}{25 * 300}} \longrightarrow C_1 = 2.87 \longrightarrow J = 0.728$$

$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{1201.7 * 10^6}{0.728 * 360 * 1150} = 3987.1\ mm^2$$

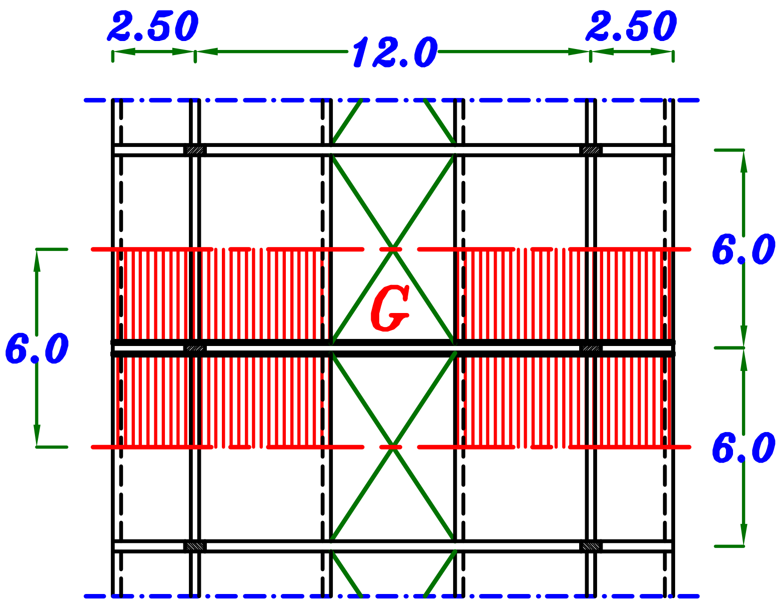
- **Check $A_{s_{min.}}$** $\qquad A_{s_{req.}} = 3987.1\ mm^2$

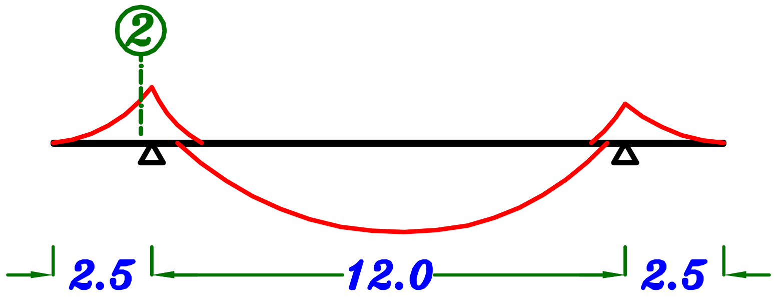
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 500 = 390.6\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 3987.1\ mm^2 \quad 9\phi 25$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{25 + 25} = 5.50 = 5.0 \text{ bars}$$

Sec. 2 $M_{U.L.} = 445.05$ kN.m   T−Sec.





كمره مقلوبه

$\boxed{K = 2.0}$

$$B = \begin{cases} C.L. - C.L. = 6.0\ m = 6000\ mm \\ 16\, t_s + b = 16 * 120 + 300 = 2220\ mm \\ K\dfrac{L}{5} + b = 2.0 * \dfrac{2500}{5} + 300 = 1300\ mm \end{cases}$$

$\boxed{B = 1300\ mm}$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, B}} \quad \therefore\ 1150 = C_1 \sqrt{\frac{445.05 * 10^6}{25 * 1300}} \longrightarrow C_1 = 9.82 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{445.05 * 10^6}{0.826 * 360 * 1150} = 1301.4\ mm^2$$

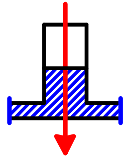
− **Check $A_{s_{min.}}$** $A_{s_{req.}} = 1301.4\ mm^2$

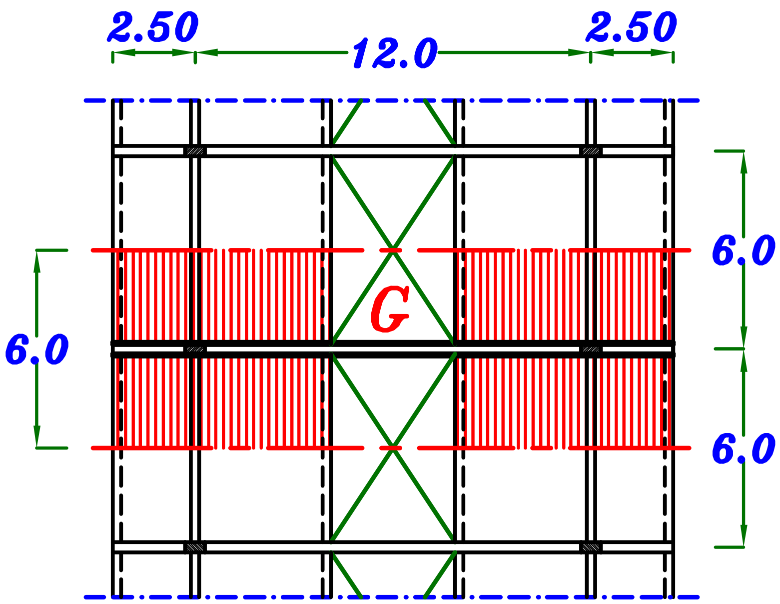
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1150 = 1078.1\ mm^2$$

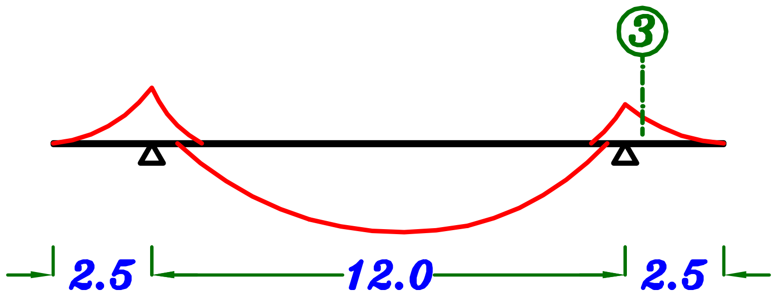
$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 1301.4\ mm^2 \quad 6\phi 18$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{18 + 25} = 6.39 = 6.0 \text{ bars}$$

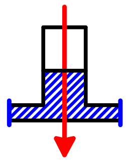
Sec. ③ $M_{U.L.} = 253.8$ kN.m T-Sec.







$$B = \begin{cases} C.L.-C.L. = 6.0\ m = 6000\ mm \\ 16\,t_s + b = 16 * 120 + 300 = 2220\ mm \\ K\dfrac{L}{5} + b = 2.0 * \dfrac{2500}{5} + 300 = 1300\ mm \end{cases}$$



كمره مقلوبه

$\boxed{K = 2.0}$

$\boxed{B = 1300\ mm}$

$$\because\ d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\,B}} \quad \therefore 1150 = C_1 \sqrt{\frac{253.8 * 10^6}{25 * 1300}} \longrightarrow C_1 = 13.0 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{253.8 * 10^6}{0.826 * 360 * 1150} = 742.2\ mm^2$$

Check $A_{s_{min.}}$ $A_{s\,req.} = 742.2\ mm^2$

$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1150 = 1078.1\ mm^2$$

$$\therefore \mu_{min.}\,b\,d > A_{s_{req.}} \xrightarrow{Use} A_{s_{min.}}$$

$$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\,b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1150 = 1078.1$$

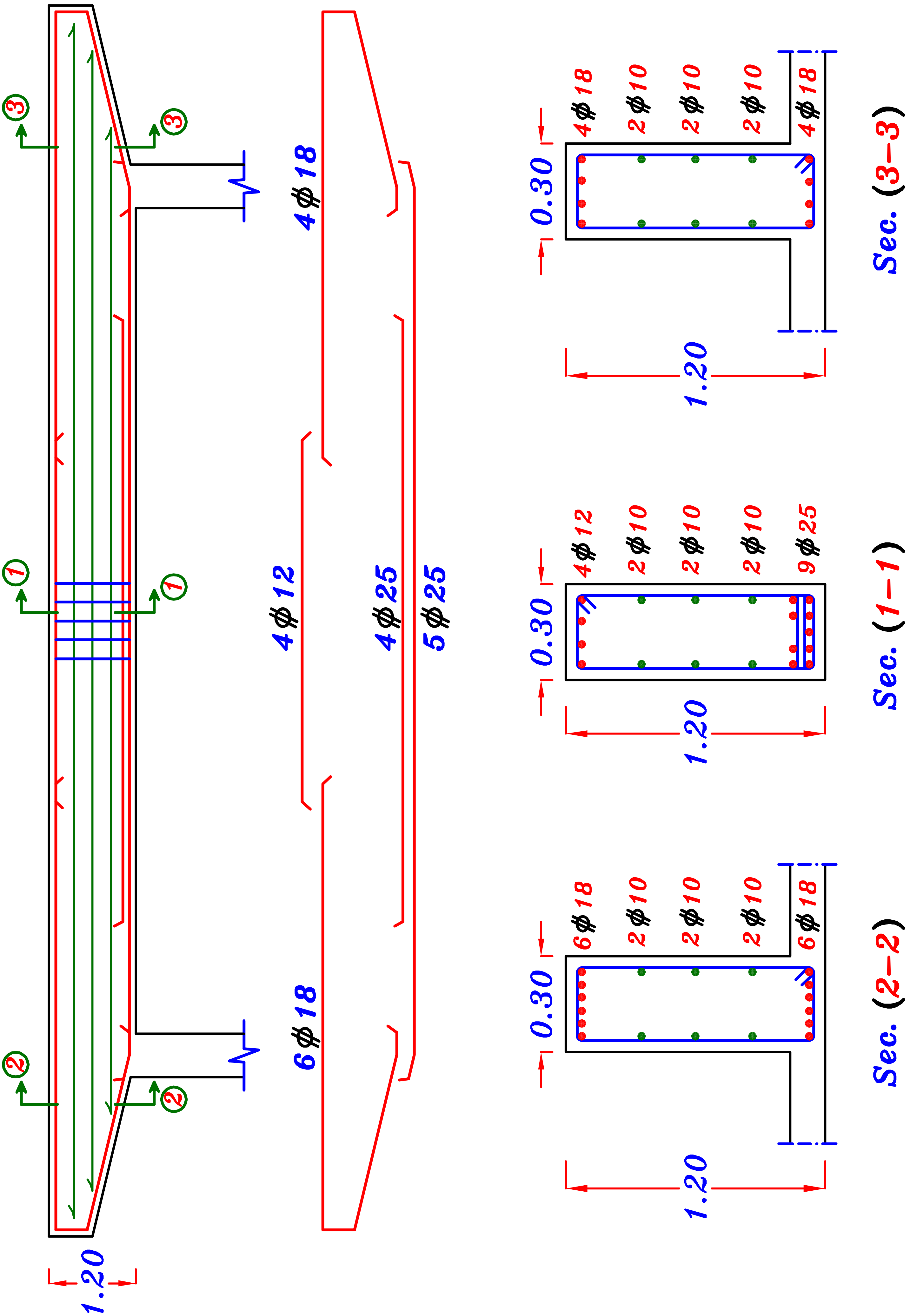
$$1.3\,A_{s_{req.}} = 1.3 * 742.2 = 964.86$$

الأقل $= 964.86$

st. 360/520 $\dfrac{0.15}{100}\,b\,d = \dfrac{0.15}{100} * 300 * 1150 = 517.5$

الأكبر $= 964.86\ mm^2$

6 ϕ 18

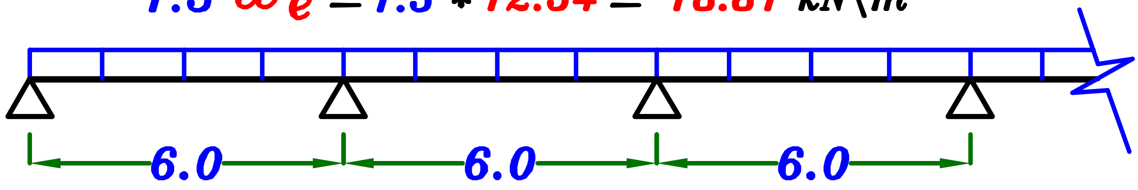


4Φ18
4Φ12
4Φ25
5Φ25
6Φ18
1.20
Sec. (3-3)
4Φ18 2Φ10 2Φ10 2Φ10 4Φ18
0.30
1.20
Sec. (1-1)
4Φ12 2Φ10 2Φ10 2Φ10 9Φ25
0.30
1.20
Sec. (2-2)
6Φ18 2Φ10 2Φ10 2Φ10 6Φ18
0.30
1.20

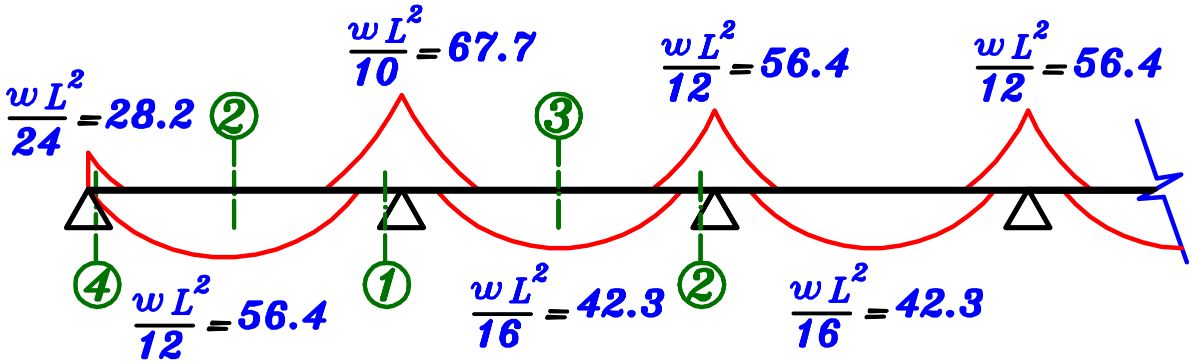
5- Design the marked beam using charts and draw its details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

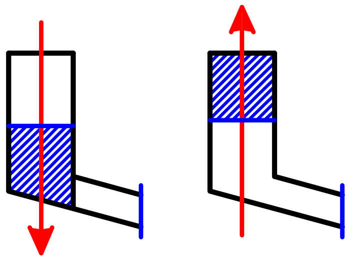
$$1.5\,w_e = 1.5 * 12.54 = 18.81 \text{ kN}\backslash\text{m}'$$

Load For Moment



B.M.D. (U.L.)

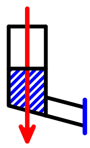




R-Sec. تصمم جميع القطاعات على انها

Sec. 1

$M_{U.L.} = 67.7$ kN.m R-Sec.



- Take $C_1 = 3.50 \longrightarrow J = 0.78$

- Get $d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} = 3.50 \sqrt{\frac{67.7 * 10^6}{25 * 250}} = 364.2$ mm

- Take $\boxed{d = 400 \text{ mm}}$, $\boxed{t = 450 \text{ mm}}$

- Get $A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{67.7 \quad * 10^6}{0.78 * 360 * 364.2} = 662.0 \text{ mm}^2$

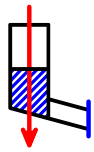
- Check $A_{s_{min.}}$ $A_{s_{req.}} = 662.0 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 400 = 312.5 \text{ mm}^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \therefore$ Take $A_s = A_{s_{req.}} = 662.0 \text{ mm}^2$ $6\phi12$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{12 + 25} = 6.08 = 6.0 \text{ bars}$$

Sec. ② $M_{U.L.} = 56.4$ kN.m R−Sec.



Take $d = 0.35$ m (The same d of Sec. ①)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 350 = C_1 \sqrt{\frac{56.4 * 10^6}{25 * 250}} \longrightarrow C_1 = 3.68 \longrightarrow J = 0.79$$

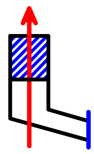
$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{56.4 * 10^6}{0.79 * 360 * 350} = 566.6\ mm^2$$

– Check $A_{s_{min.}}$ $A_{s_{req.}} = 566.6\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 400 = 312.5\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 566.6\ mm^2 \quad 5\phi 12$$

Sec. ③ $M_{U.L.} = 42.3$ kN.m R−Sec.



Take $d = 0.35$ m (The same d of Sec. ①)

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 350 = C_1 \sqrt{\frac{42.3 * 10^6}{25 * 250}} \longrightarrow C_1 = 4.25 \longrightarrow J = 0.811$$

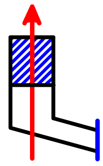
$$\therefore A_s = \frac{M_{U.L.}}{J\ F_y\ d} = \frac{42.3 * 10^6}{0.811 * 360 * 350} = 413.9\ mm^2$$

– Check $A_{s_{min.}}$ $A_{s_{req.}} = 413.9\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 400 = 312.5\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 413.9\ mm^2 \quad 4\phi 12$$

Sec. ④ $\quad M_{U.L.} = 28.2 \ kN.m$ $\quad$ R–Sec.



$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}} \quad \therefore 350 = C_1 \sqrt{\frac{28.2 * 10^6}{25 * 250}} \longrightarrow C_1 = 5.21 \longrightarrow J = 0.826$

$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{28.2 * 10^6}{0.826 * 360 * 350} = 270.9 \ mm^2$

Check $A_{s_{min.}}$ $\quad A_{s\ req.} = 270.9 \ mm^2$

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 400 = 312.5 \ mm^2$

$\therefore \mu_{min.}\, b\, d > A_{s_{req.}} \xrightarrow{Use} A_{s_{min.}}$

$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\, b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 400 = 312.5$

$1.3\, A_{s_{req.}} = 1.3 * 270.9 = 352.1$

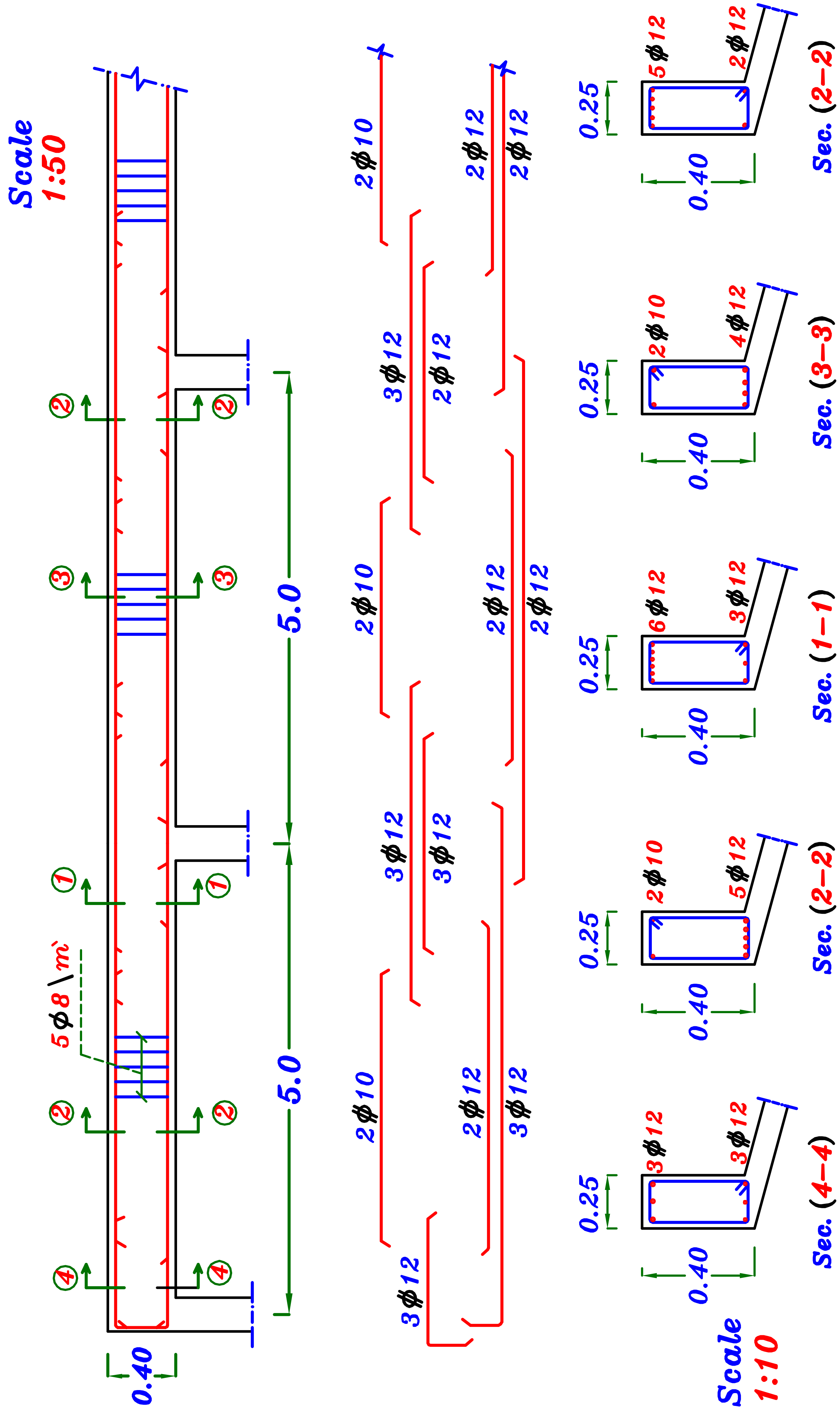
الأقل $= 312.5$

st. 360/520 $\quad \frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 250 * 400 = 150$

الأكبر $= 312.5 \ mm^2$

$3 \phi 12$

RFT. of B



Scale 1:50
5ϕ8\m`
0.40
5.0
5.0
2ϕ10
3ϕ12
2ϕ12
2ϕ10
2ϕ12
2ϕ12
3ϕ12
3ϕ12
2ϕ10
2ϕ12
3ϕ12
3ϕ12
2ϕ12
2ϕ12
0.25
0.40
5ϕ12
2ϕ12
Sec. (2-2)
2ϕ10
4ϕ12
Sec. (3-3)
6ϕ12
3ϕ12
Sec. (1-1)
2ϕ10
5ϕ12
Sec. (2-2)
3ϕ12
3ϕ12
Sec. (4-4)
Scale 1:10

Example.

Figure 1 shows a sectional elevation and plan of a reinforced concrete shed. The shed covered by reinforced concrete slabs supported by a system of secondary beams (B_1) and Girders (G_1 & G_2) It is required to :

1- Draw a structural plan showing the pattern of load distribution.

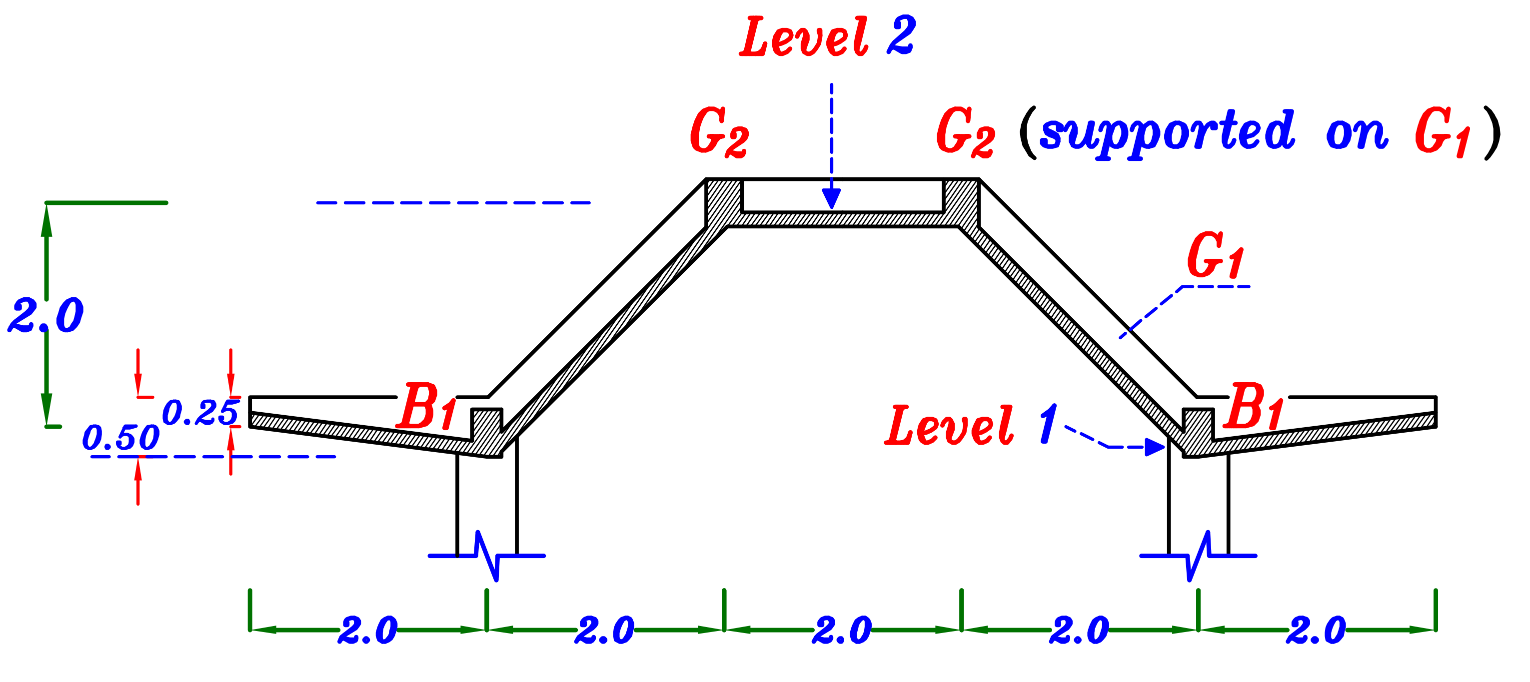
2- Calculate the equivalent working loads for shear and moment For secondary Beams (B_1) and Girders (G_1 & G_2) .

3- Draw the N.F.D. (Total Loads) , S.F.D. (Total Loads) and (max-max B.M.D.) For Girder (G_1) only, Using ultimate limit loads.

4- Design Girder (G_2) using Charts and draw details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

Data:

- Slab thickness $t_s = 120$ mm
- Live load = 1.5 kN\m^2 HL. projection.
- Floor cover = 1.0 kN\m^2
- Own weight of beams = 3.0 kN\m
- Own weight of girders = 6.0 kN\m
- $F_{cu} = 25$ N\mm^2 st. 360/520



Cross-Section (X-X)

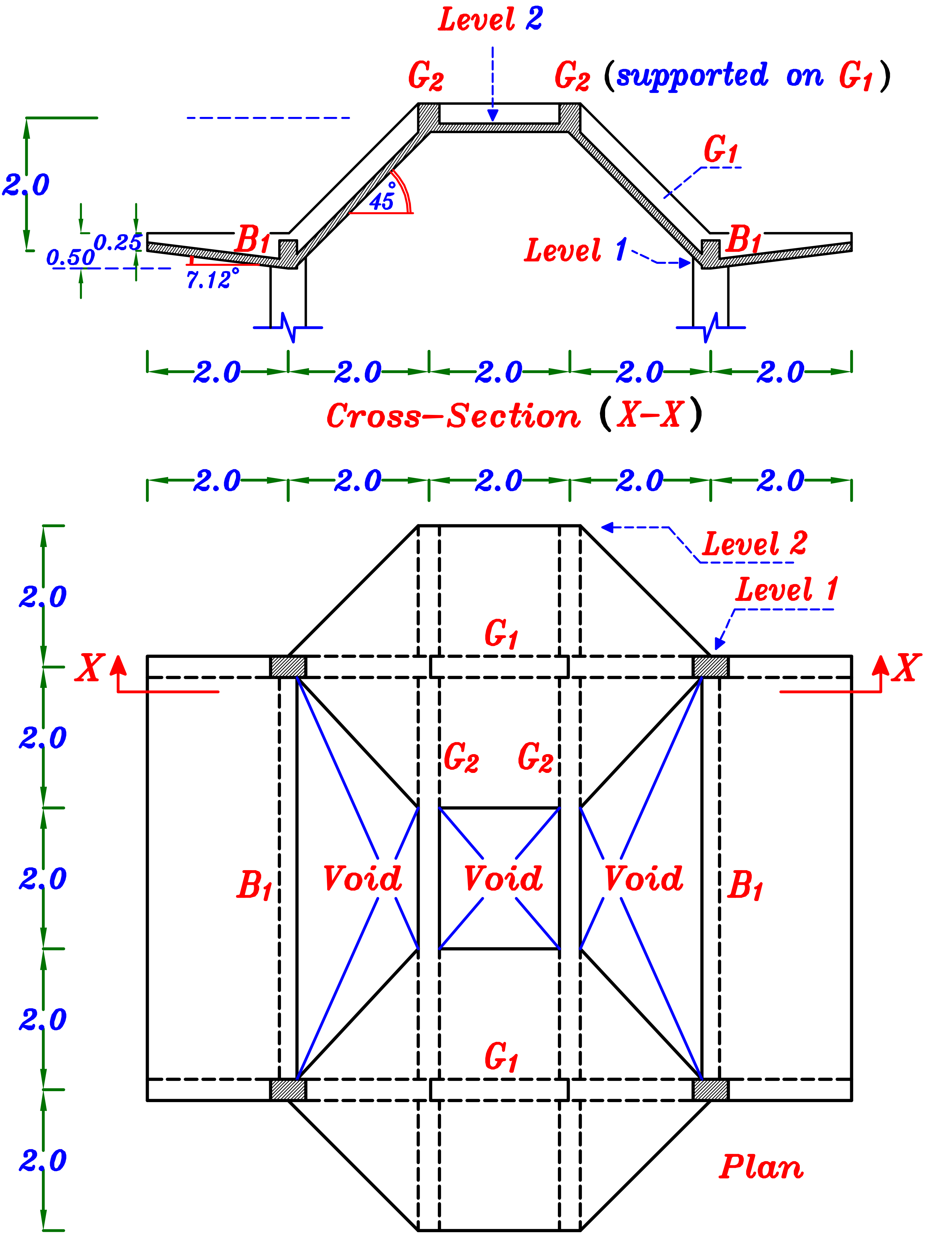
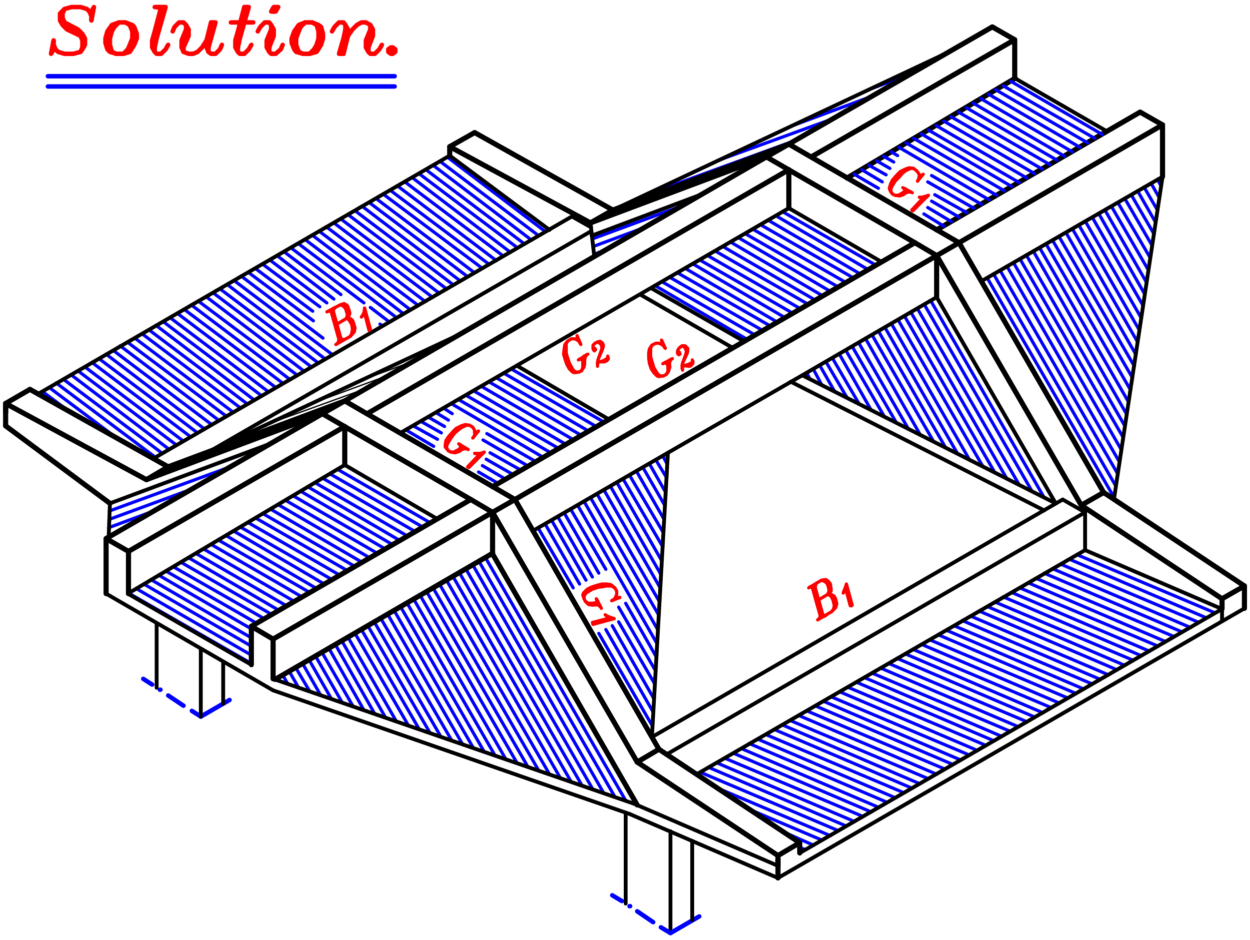
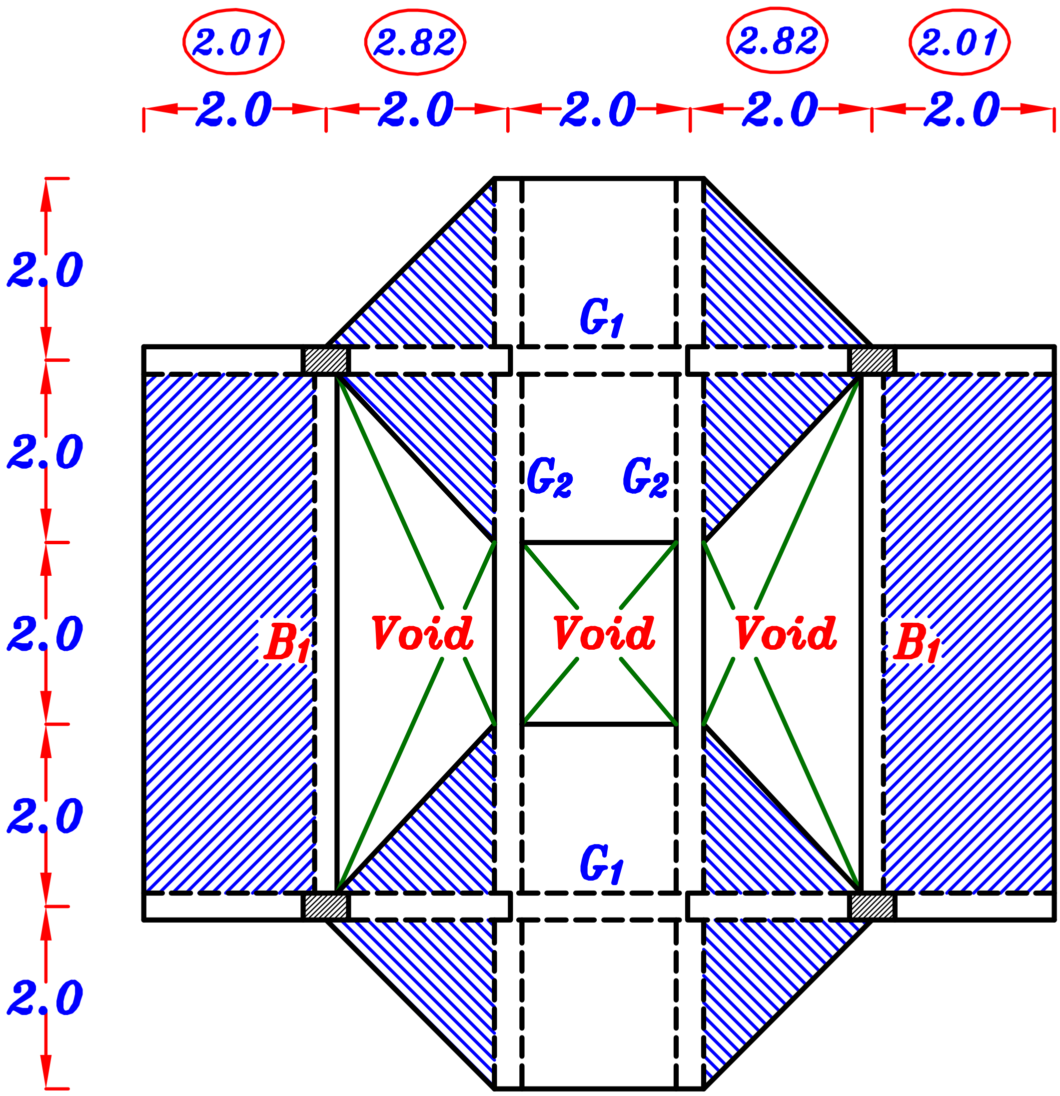

Level 2
G2
G2 (supported on G1)
G1
2.0
0.25
0.50
B1
45°
7.12°
Level 1
B1
2.0
2.0
2.0
2.0
2.0
Cross-Section (X-X)
2.0
2.0
2.0
2.0
2.0
Level 2
Level 1
2.0
2.0
2.0
2.0
2.0
X
X
G1
G2
G2
B1
Void
Void
Void
B1
G1
Plan

Figure 1

Solution.



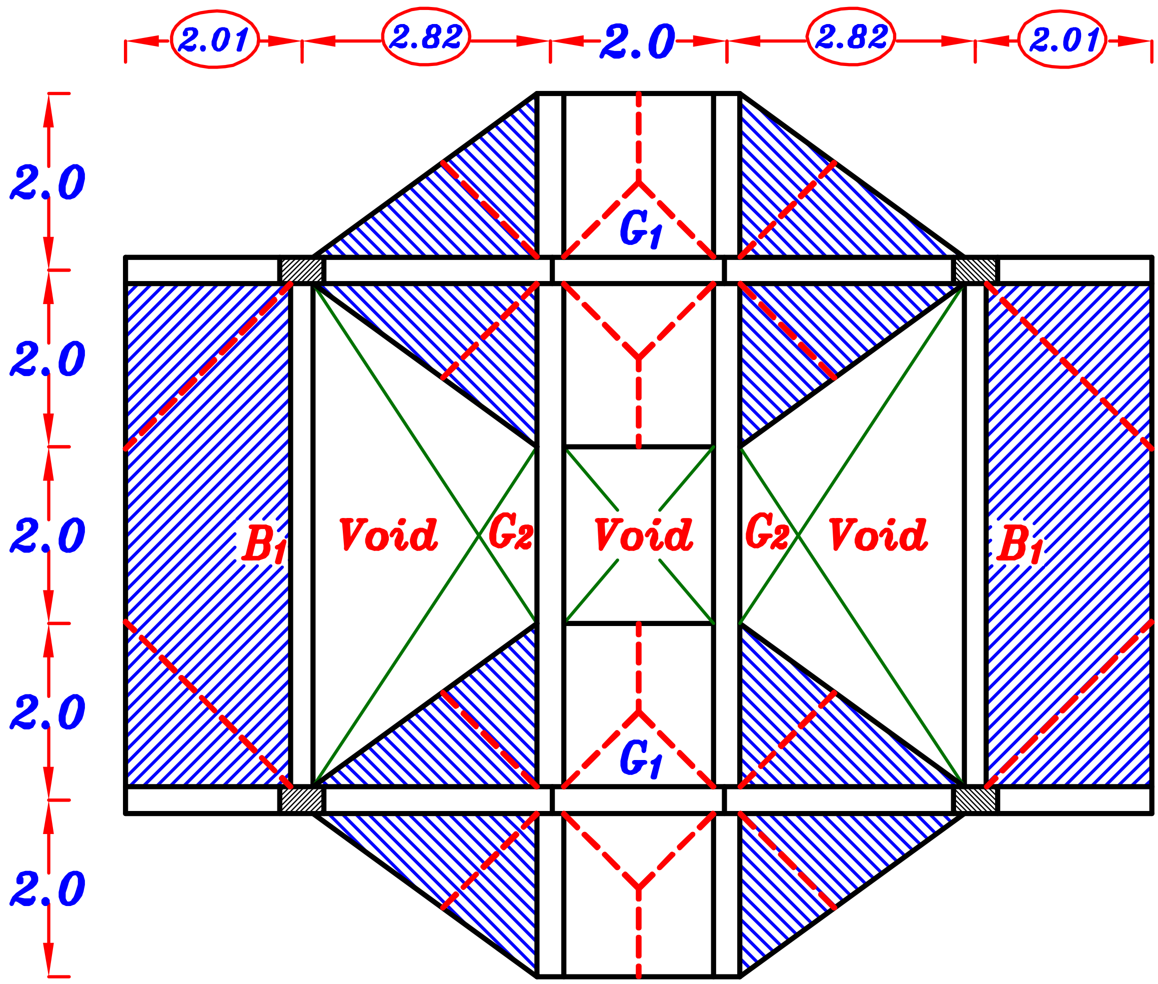
B1
G2
G2
G1
G1
G1
B1



2.01
2.82
2.82
2.01
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
G1
G2
G2
B1
Void
Void
Void
B1
G1

1 – Draw a structural plan showing the pattern of load distribution.

أرسم ال plan بالاطوال الحقيقيه بمقياس رسم مناسب لقياس بعض الاطوال منه .



g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.0 = 4.5 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 1.5 \ kN\backslash m^2 \text{ ----- HL. Slab.}$$

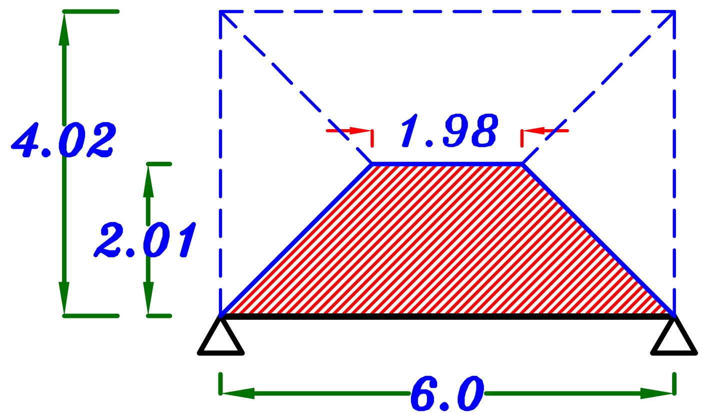
$$p_{si1} = L.L. * Cos\,\theta = 1.5 * Cos\ 45^\circ = 1.06 \ kN\backslash m^2 \text{ --- For Inclination } 45^\circ$$

$$p_{si2} = L.L. * Cos\,\theta = 1.5 * Cos\ 7.12^\circ = 1.49 \ kN\backslash m^2 \text{ --- For Inclination } 7.12^\circ$$

$\boxed{g_s = 4.5 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.5 \ kN\backslash m^2}$

$\boxed{p_{si1} = 1.06 \ kN\backslash m^2}$, $\boxed{p_{si2} = 1.49 \ kN\backslash m^2}$

B_1

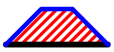


For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.02}{6}\right) = 0.665$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.02}{6}\right)^2 = 0.85$$

Load For Shear.



$$g_a = o.w. + C_a\, g_s\, L_c = 3.0 + (0.665)(4.50)(2.01) = 9.01 \ kN\backslash m`$$

$$p_a = C_a\, p_{si2}\, L_c = (0.665)(1.49)(2.01) = 1.99 \ kN\backslash m`$$

$$w_a = g_a + p_a = 9.01 + 1.99 = 11.0 \ kN\backslash m`$$

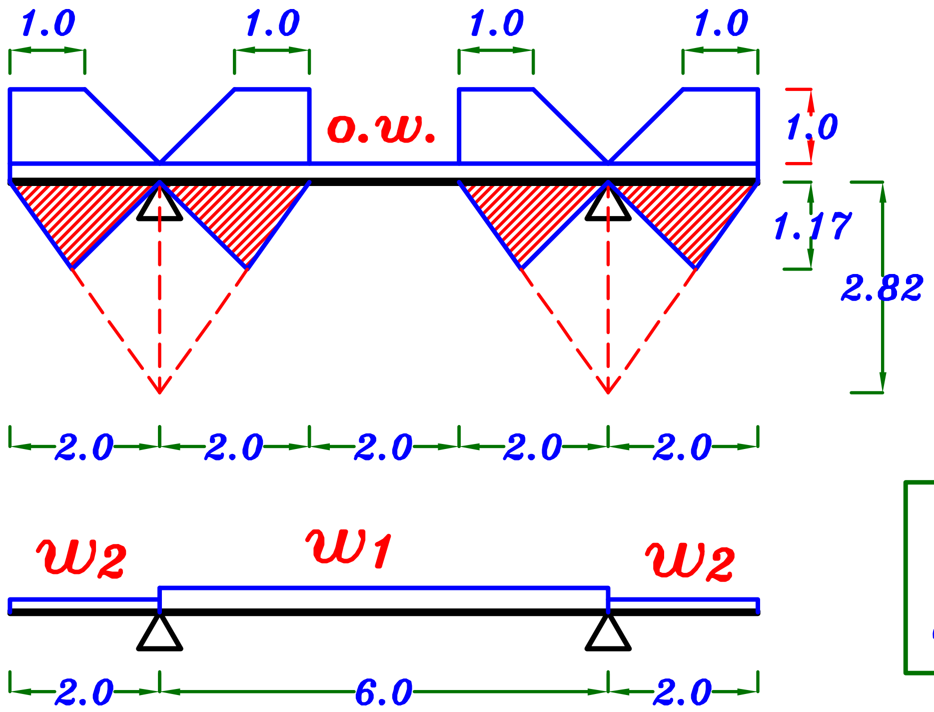
Load For Moment.

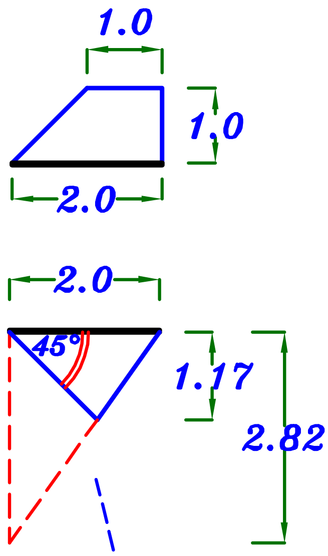
$$g_e = o.w. + C_e\, g_s\, L_c = 3.0 + (0.85)(4.50)(2.01) = 10.69 \ kN\backslash m`$$

$$p_e = C_e\, p_{si2}\, L_c = (0.85)(1.49)(2.01) = 2.54 \ kN\backslash m`$$

$$w_e = g_e + p_e = 10.69 + 2.54 = 13.23 \ kN\backslash m`$$

G_2





يتم حساب الابعاد
من القياس من على الرسمه
لذا تم رسمها بمقياس رسم مناسب

w_1

$$\frac{\sum area}{span}\,1 = \frac{2\left(\frac{2+1}{2}\right)(1.0)}{6.0} = 0.50$$

$$\frac{\sum area}{span}\,2 = \frac{2\left(\frac{1}{2}*2*1.17\right)}{6.0} = 0.39$$

Load For Shear = Load For Moment.

$$g_{1a} = g_{1e} = O.W. + \frac{\sum area}{span}\,1 * g_s + \frac{\sum area}{span}\,2 * g_s$$

$$= 6.0 + (0.50)(4.5) + (0.39)(4.5) = 10.0 \quad kN\backslash m'$$

$$p_{1a} = p_{1e} = \frac{\sum area}{span}\,1 * p_{sh} + \frac{\sum area}{span}\,2 * p_{si1}$$

$$= (0.50)(1.5) + (0.39)(1.06) = 1.163 \; kN\backslash m'$$

$$w_{1a} = w_{1e} = g_1 + p_1 = 10.0 + 1.163 = 11.163 \; kN\backslash m'$$

w_2

$$\frac{\sum area}{span}\,1 = \frac{\left(\frac{2+1}{2}\right)(1.0)}{2.0} = 0.75$$

$$\frac{\sum area}{span}\,2 = \frac{\left(\frac{1}{2} * 2 * 1.17\right)}{2.0} = 0.585$$

Load For Shear = Load For Moment.

$$g_{2a} = g_{2e} = O.W. + \frac{\sum area}{span}\,1 * g_s + \frac{\sum area}{span}\,2 * g_s$$

$$= 6.0 + (0.75)(4.5) + (0.585)(4.5) = 12.0 \ kN\backslash m'$$

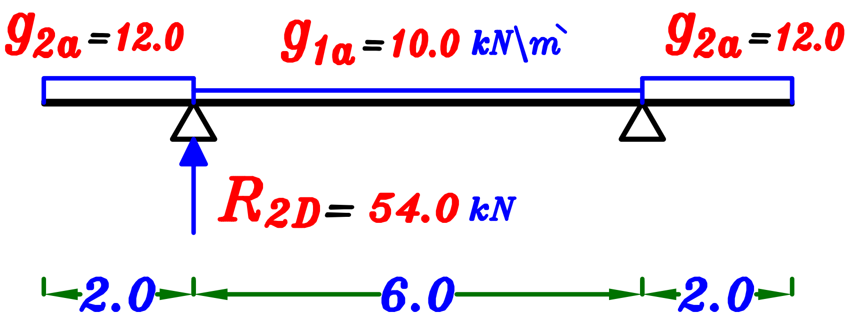
$$p_{2a} = p_{2e} = \frac{\sum area}{span}\,1 * p_{sh} + \frac{\sum area}{span}\,2 * p_{si1}$$

$$= (0.75)(1.5) + (0.585)(1.06) = 1.74 \ kN\backslash m'$$

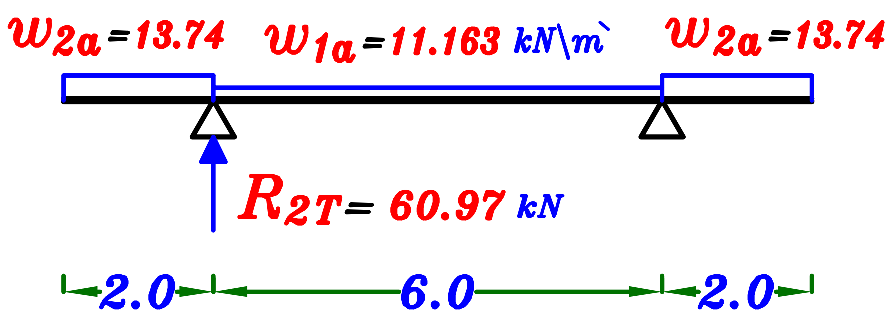
$$w_{2a} = w_{2e} = g_2 + p_2 = 12.0 + 1.74 = 13.74 \ kN\backslash m'$$

Reaction of gireder G_2

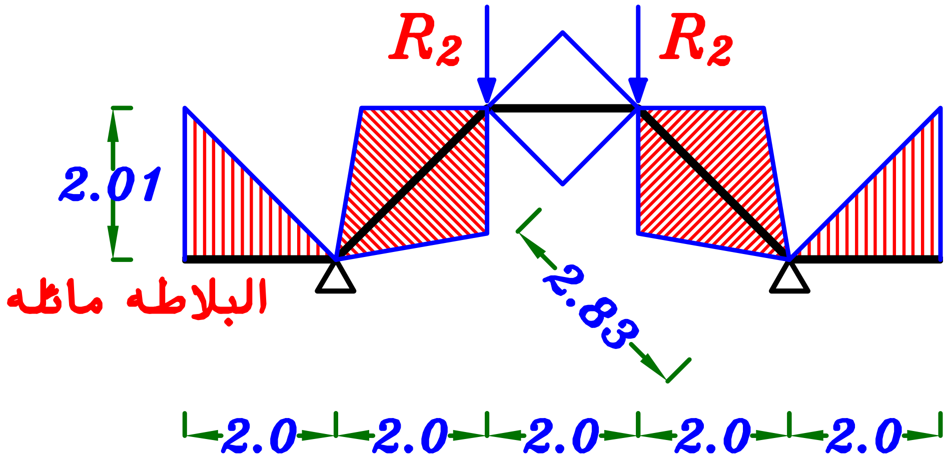
$$\boxed{R_{2D} = 54.0 \ kN}$$



$$\boxed{R_{2T} = 60.97 \ kN}$$

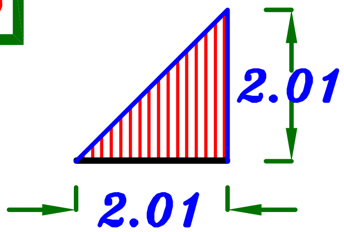


G_1

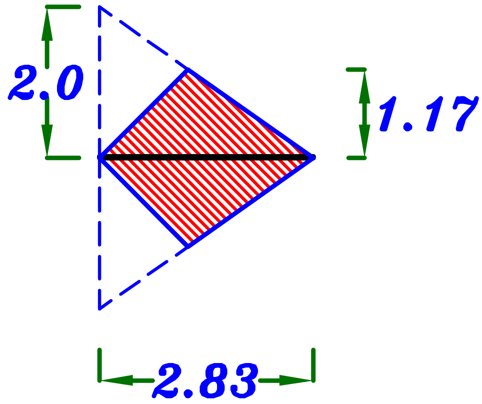


البلاطه مائله و لكن ال girder cantilever أفقى

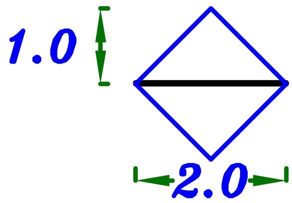
$$\frac{\sum area}{span} = \frac{\left(\frac{1}{2} * 2.01 * 2.01\right)}{2.0} = 1.01$$

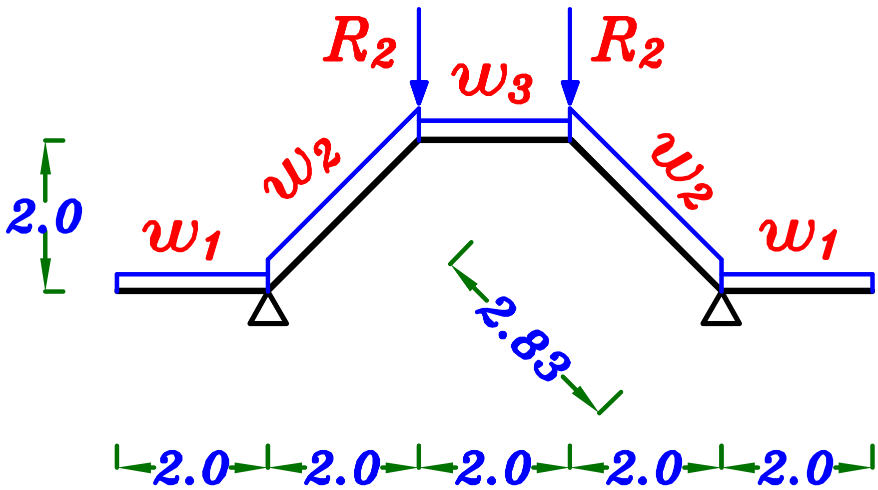


$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2.83 * 1.17\right)}{2.83} = 1.17$$



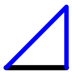
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2 * 1.0\right)}{2.0} = 1.0$$





$w1$

Load For Shear = Load For Moment



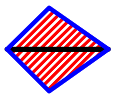
$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.01)(4.5) = 10.545 \ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_{si2} = (1.01)(1.49) = 1.505 \ kN\backslash m'$$

$$w_1 = g + p = 10.545 + 1.505 = 12.05 \ kN\backslash m'$$

$w2$

Load For Shear = Load For Moment



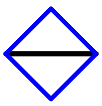
$$g_2 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.17)(4.5) = 11.265 \ kN\backslash m'$$

$$p_2 = \frac{\sum area}{span} * p_{si1} = (1.17)(1.06) = 1.24 \ kN\backslash m'$$

$$w_2 = g + p = 11.265 + 1.24 = 12.505 \ kN\backslash m'$$

$w3$

Load For Shear = Load For Moment



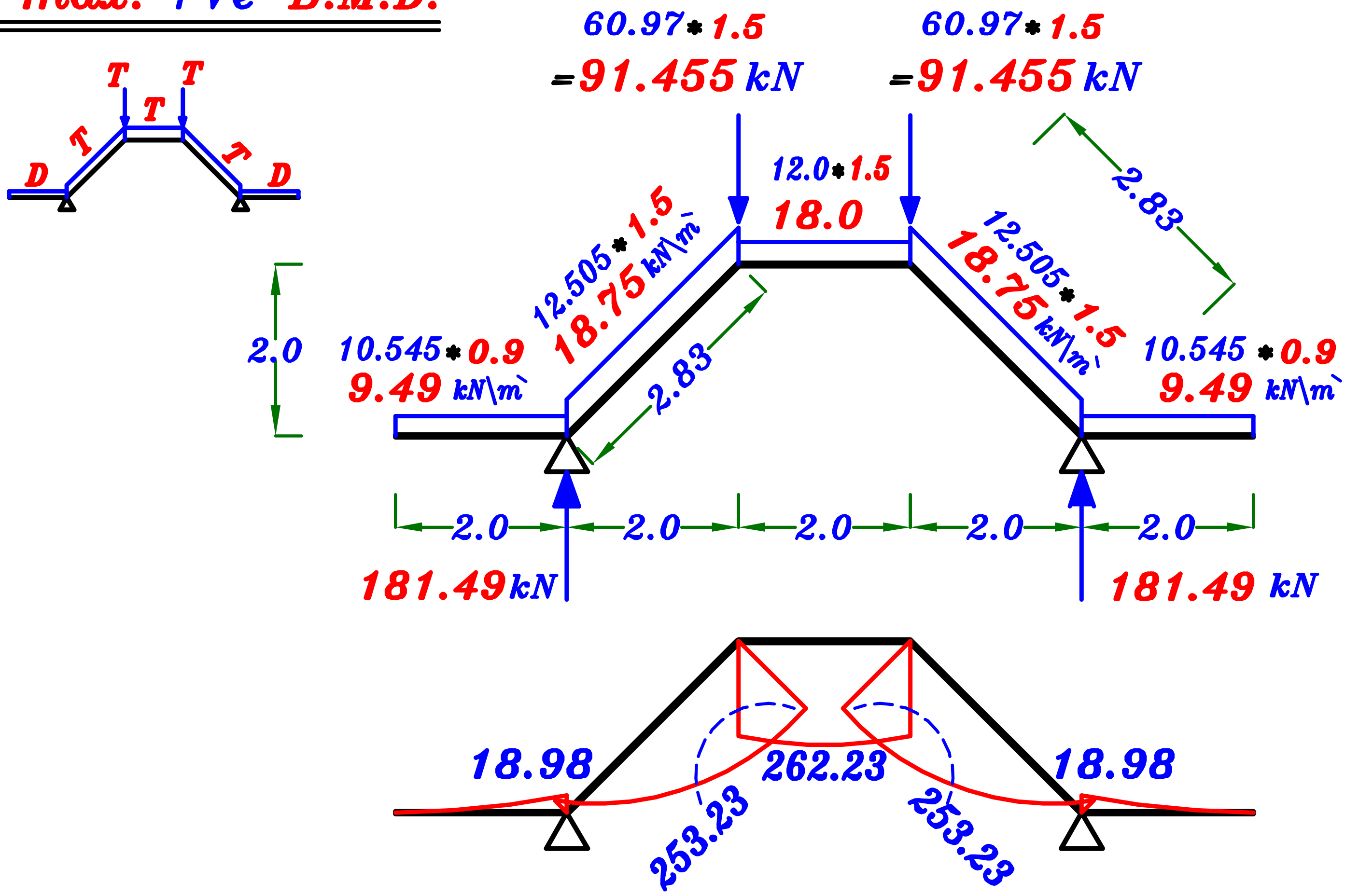
$$g_3 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.0)(4.5) = 10.5 \ kN\backslash m'$$

$$p_3 = \frac{\sum area}{span} * p_{sh} = (1.0)(1.5) = 1.50 \ kN\backslash m'$$

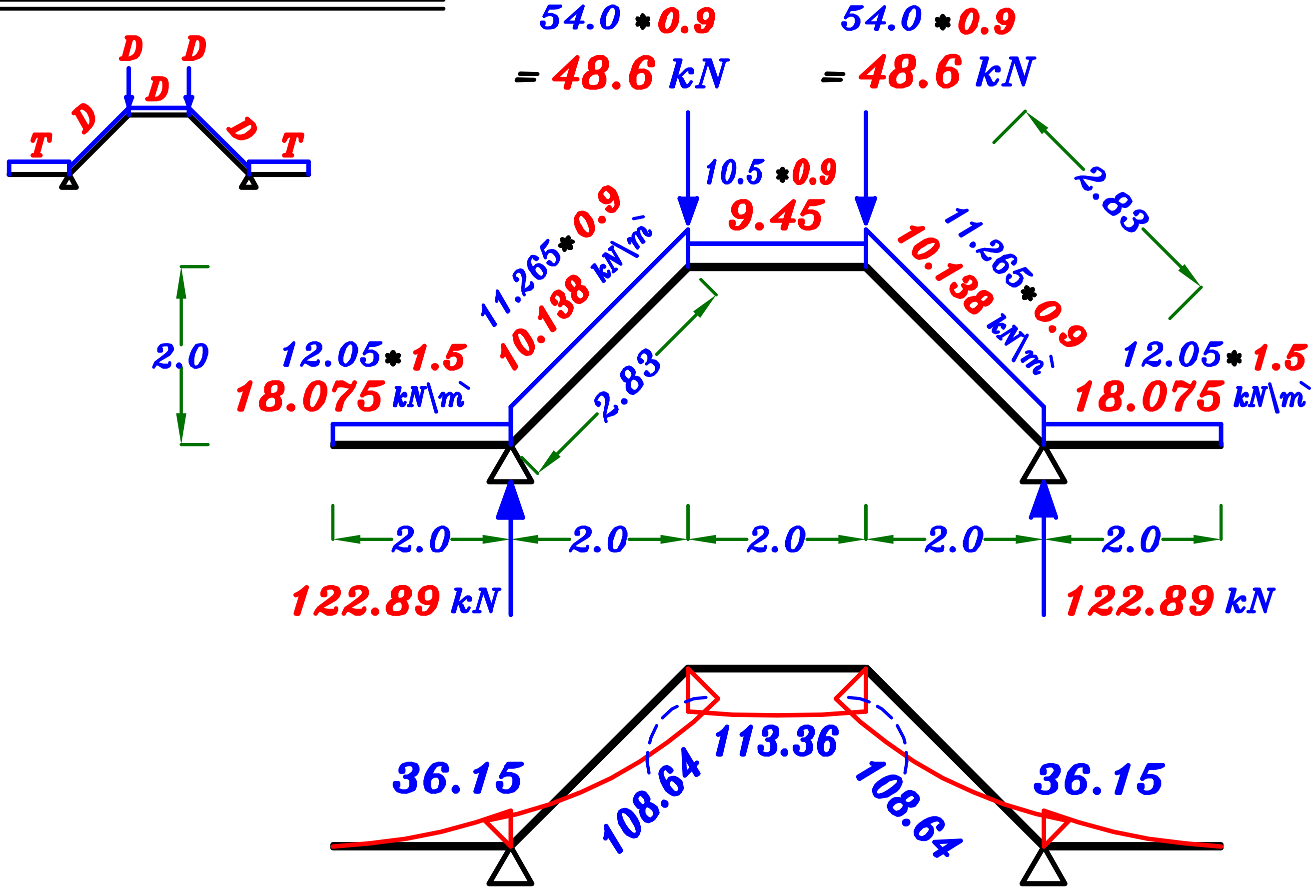
$$w_3 = g + p = 10.5 + 1.50 = 12.0 \ kN\backslash m'$$

max–max U.L. B.M.D. For the Girder. G_1

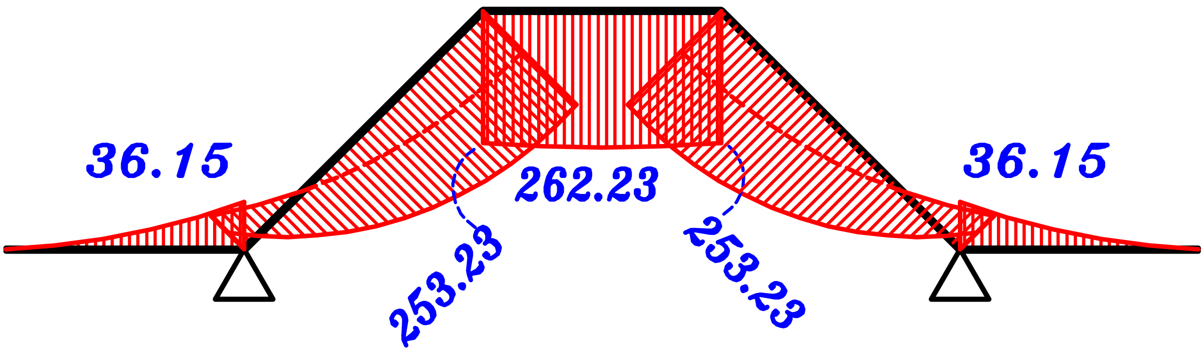
1- max. +Ve B.M.D.



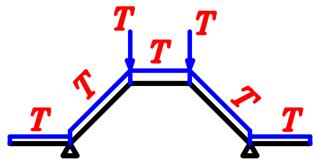
2- max. −Ve B.M.D.

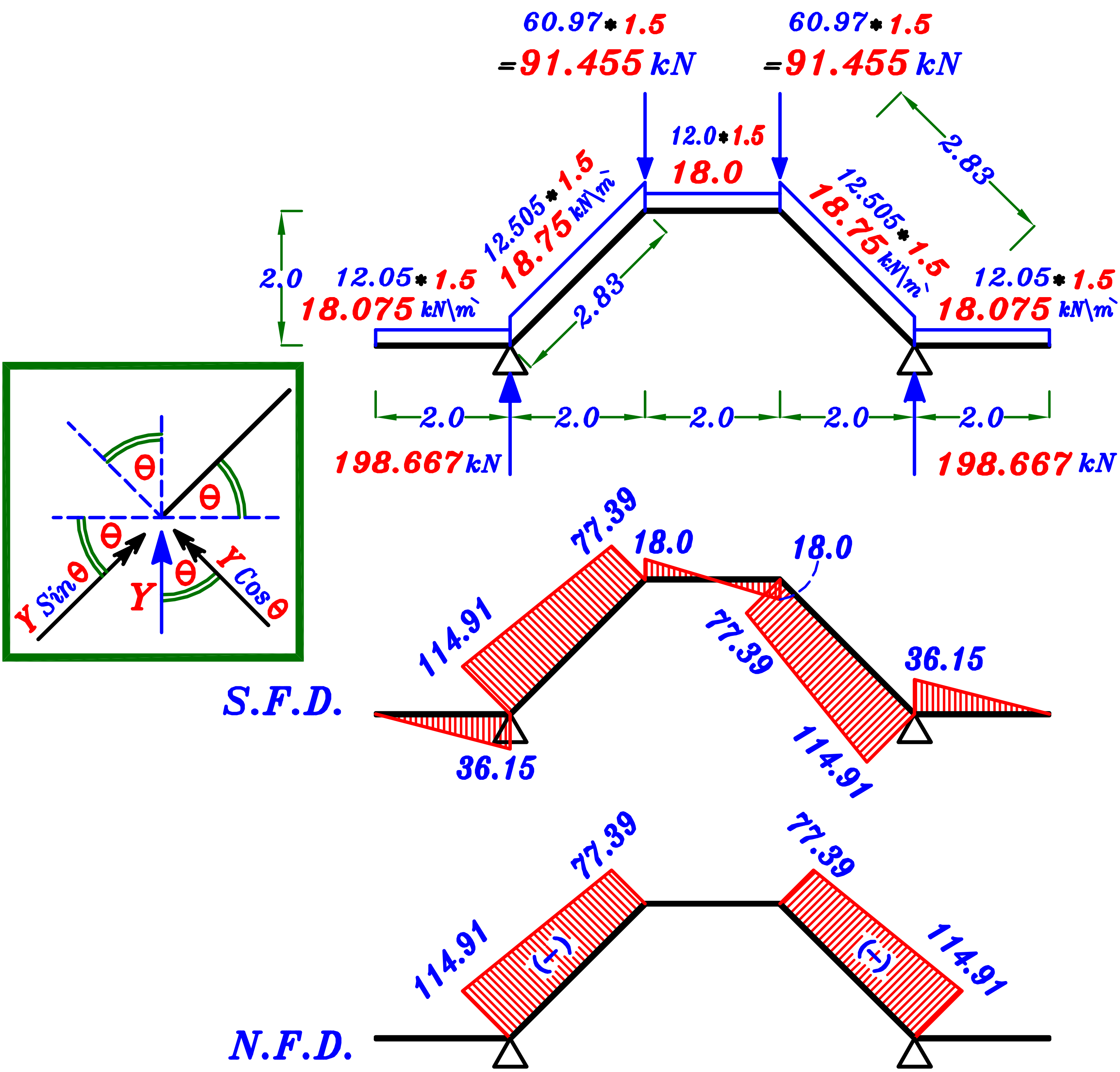


max-max U.L. B.M.D. For the Girder. G_1



U.L. S.F.D. & N.F.D. For the Girder G_1

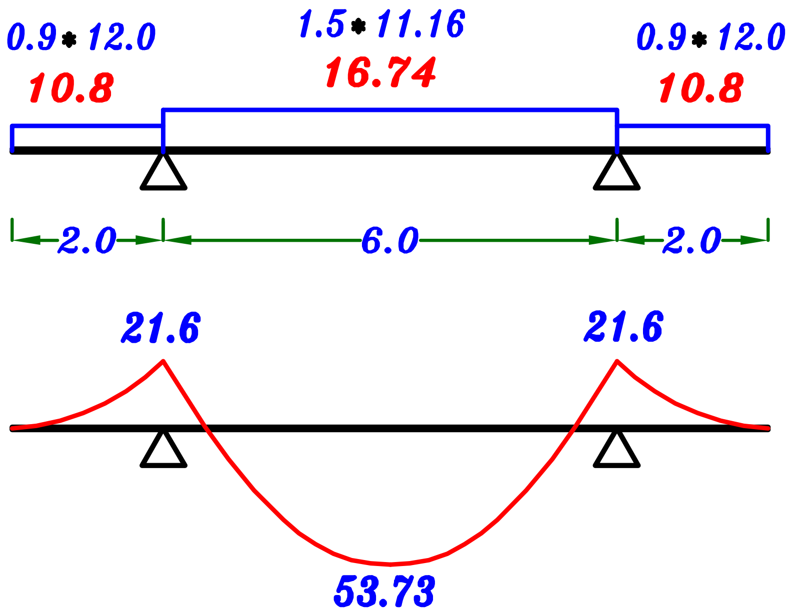




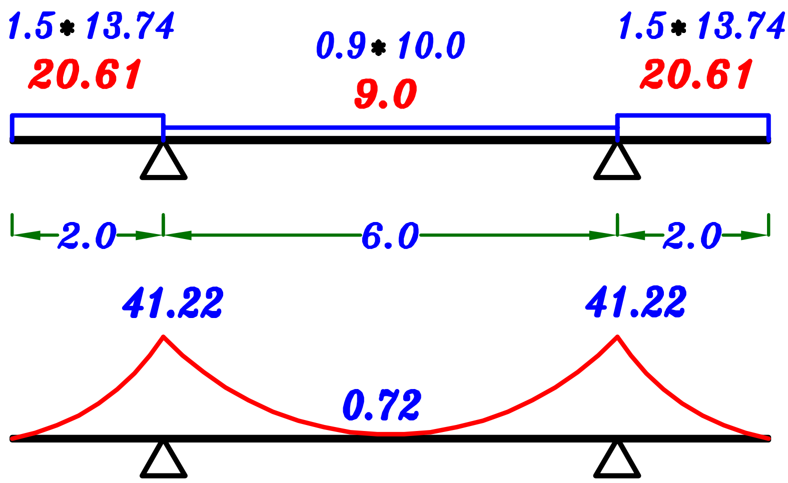
4- Design Girder (G_2) using Charts and draw details of RFT. in elevation to scale 1:50 and cross sections to scale 1:10

max.–max. B.M.D. on Girder (G_2)

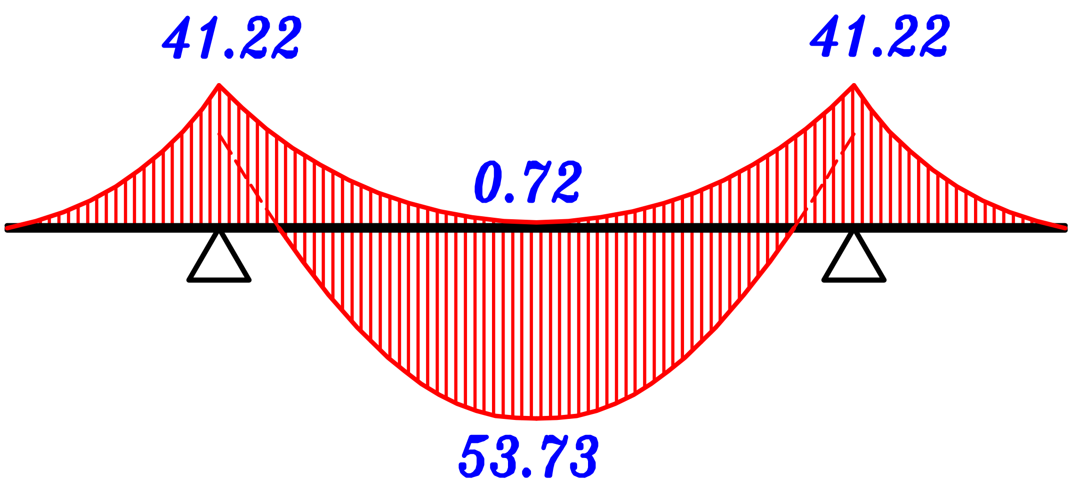
max (+Ve) B.M.D.

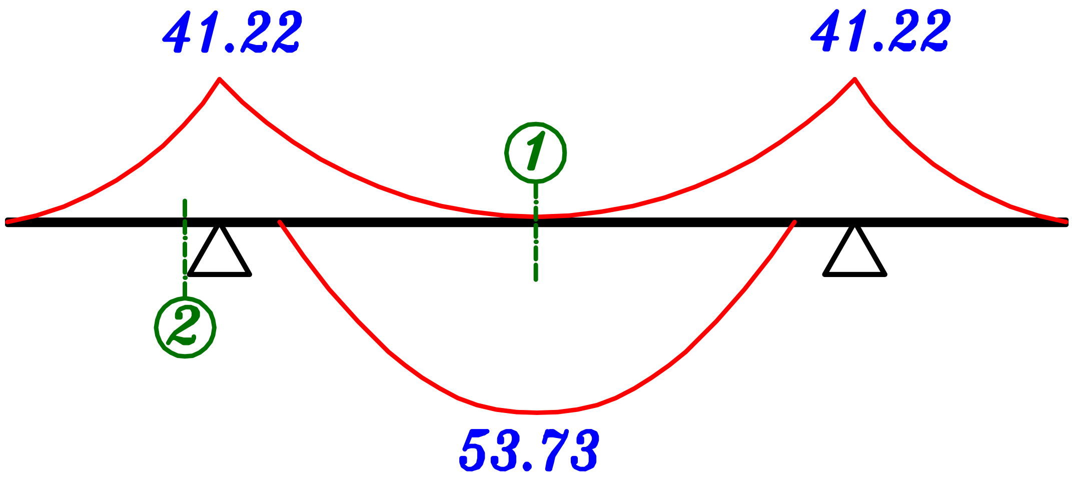


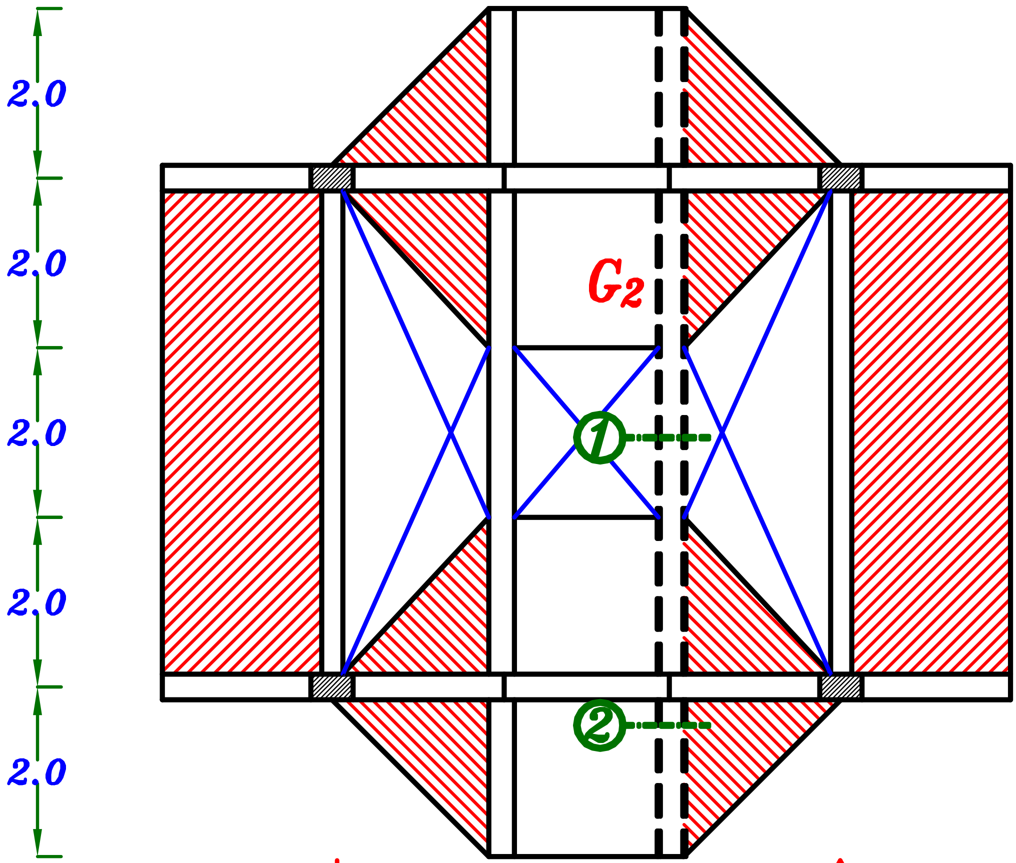
max (–Ve) B.M.D.

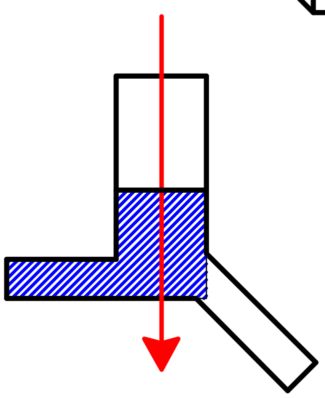


max.–max. B.M.D. on Girder (G_2)



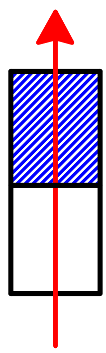






Sec.(2-2)

L-Sec.



Sec.(1-1)

R-Sec.

$\because\ M_L < 2\,M_R \quad \therefore$ Design R-Sec. at First.

Sec. 1 $M_{U.L.} = 53.73$ kN.m R-Sec.

- Take $C_1 = 3.50 \longrightarrow J = 0.78$

- Get $d = C_1 \sqrt{\dfrac{M_{U.L.}}{F_{cu}\, b}} = 3.50 \sqrt{\dfrac{53.73 * 10^6}{25 * 250}} = 324.5$ mm

- Take $\boxed{d = 350 \text{ mm}}$, $\boxed{t = 400 \text{ mm}}$

- Get $A_s = \dfrac{M_{U.L.}}{J\, F_y\, d} = \dfrac{53.73 * 10^6}{0.78 * 360 * 324.5} = 589.6 \text{ mm}^2$

- Check $A_{s_{min.}}$ $A_{s_{req.}} = 589.6 \text{ mm}^2$

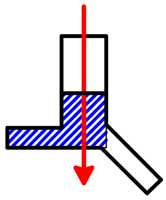
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4 \text{ mm}^2$$

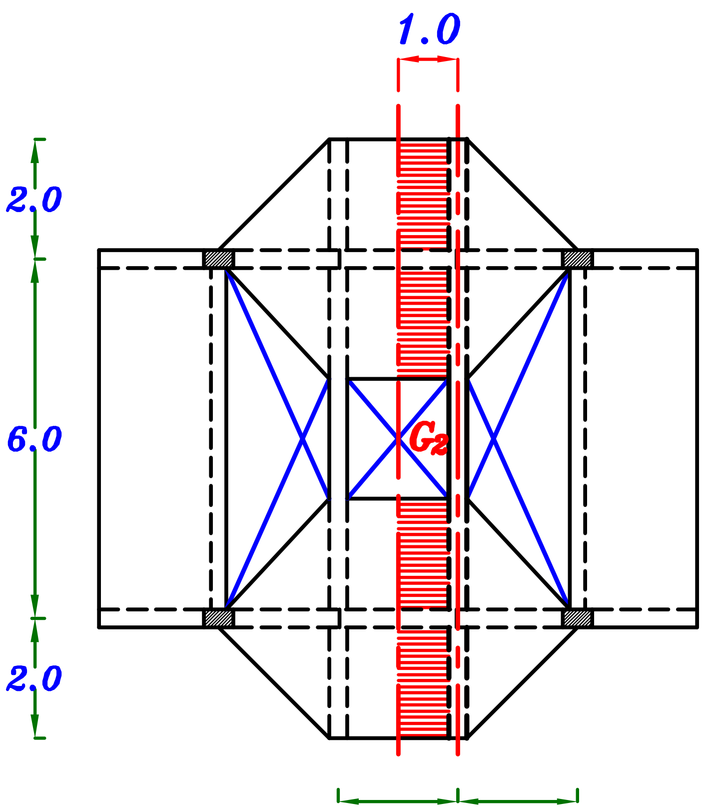
$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 589.6 \text{ mm}^2$ $6\phi 12$

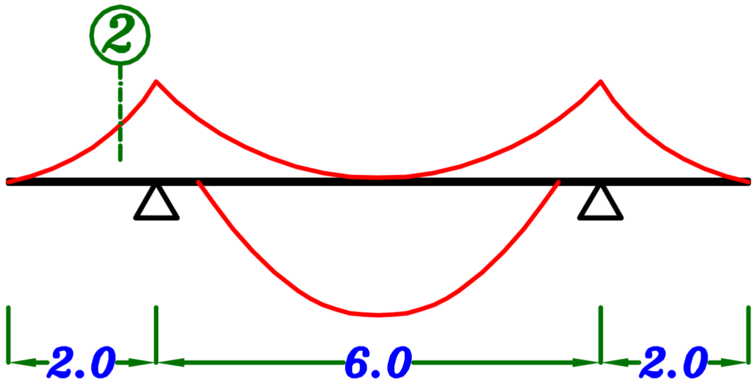
$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{12 + 25} = 6.08 = 6.0 \text{ bars}$$

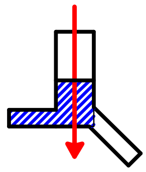
Sec. ②

$M_{U.L.} = 41.22$ kN.m   L−Sec.









كمره مقلوبه

$\boxed{K = 2.0}$

$$B = \begin{cases} C.L.-C.L. = 1.0 \text{ m} = 1000 \text{ mm} \\ 6\, t_s + b = 6 * 120 + 250 = 970 \text{ mm} \\ K \dfrac{L}{10} + b = 2.0 * \dfrac{2000}{10} + 250 = 650 \text{ mm} \end{cases}$$

$$\boxed{B = 650 \text{ mm}}$$

$$\because d = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, B}} \quad \therefore 350 = C_1 \sqrt{\frac{41.22 * 10^6}{25 * 650}} \longrightarrow C_1 = 6.94 \longrightarrow J = 0.826$$

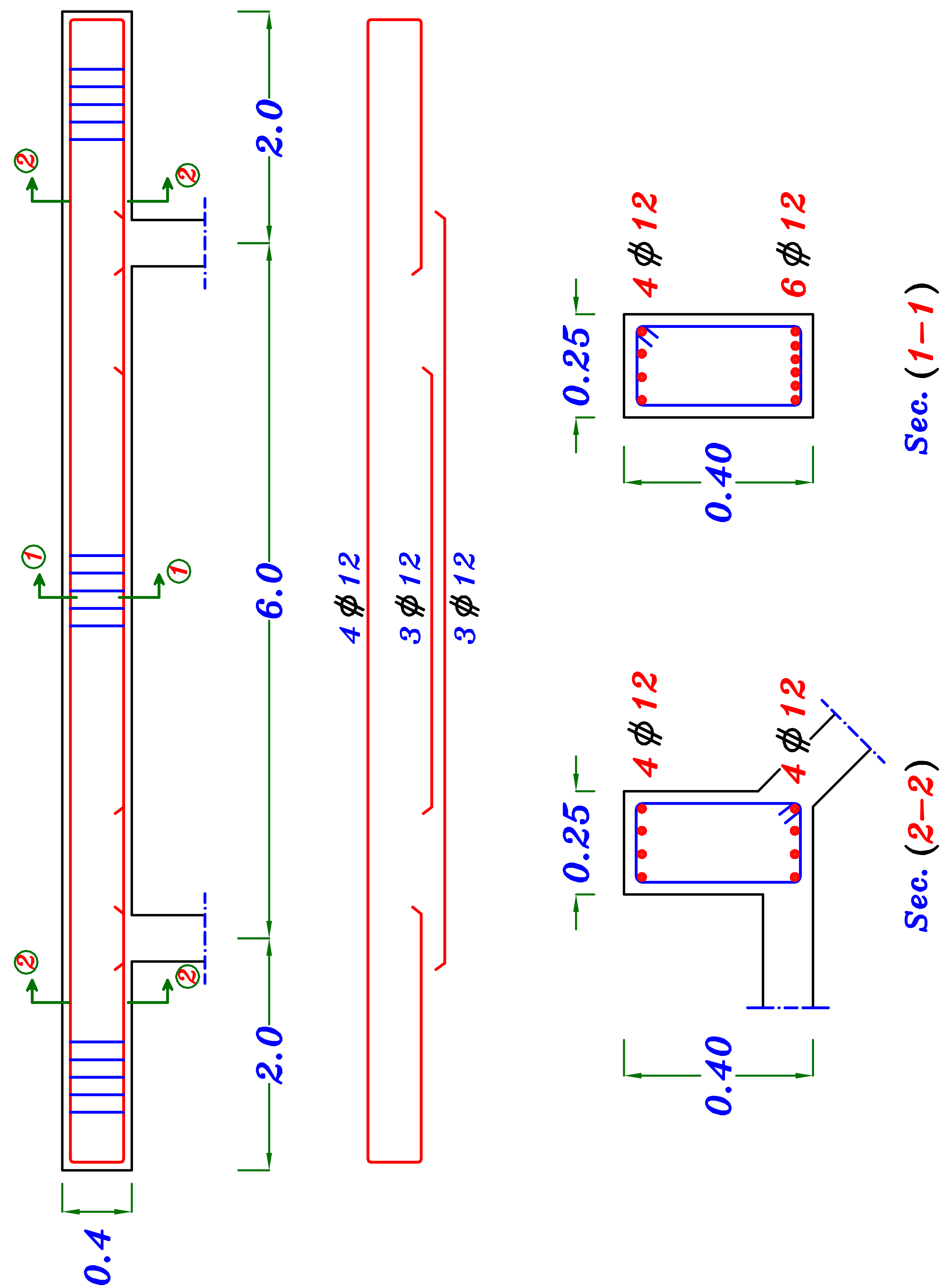
$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{41.22 * 10^6}{0.826 * 360 * 350} = 396.0 \text{ mm}^2$$

– Check $A_{s_{min.}}$ $A_{s_{req.}} = 396.0 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 350 = 273.4 \text{ mm}^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 396.0 \text{ mm}^2$$

4ϕ12



2.0
6.0
2.0
0.4
4 φ 12
3 φ 12
3 φ 12
1
2
0.25
0.40
4 φ 12
6 φ 12
Sec. (1–1)
0.25
0.40
4 φ 12
4 φ 12
Sec. (2–2)